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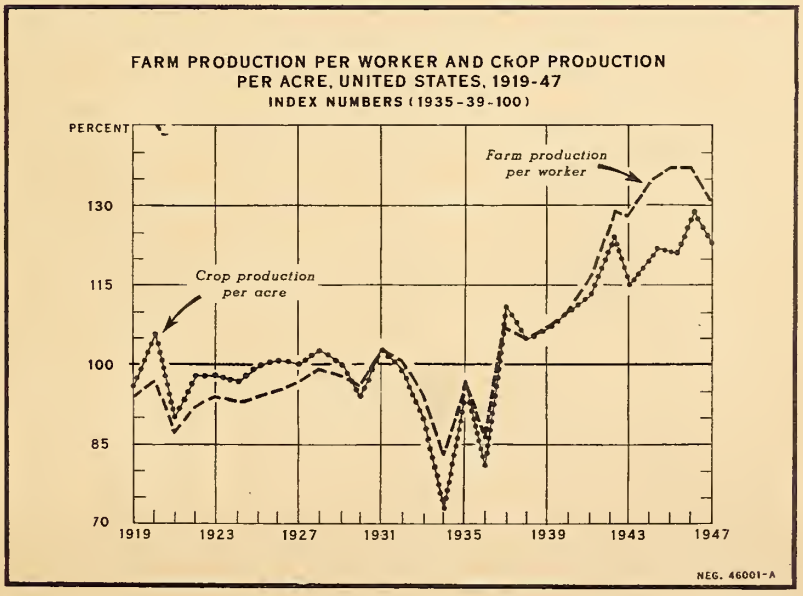
Changes IN FARMING



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PREFACE

This report is a revision of the summary of a study that was begun in the fall of 1944 with the purpose of analyzing the changes in farming during the interwar and war years, appraising the forces back of the large increases in production, and evaluating some of their peacetime implications. That summary was issued in June 1946 under the title "Changes in Farming in War and Peace." We are now in the third crop year of the postwar period, and this revision of the earlier summary includes our production experience in the years 1946 and 1947; also other new information, especially with respect to trends in farm sizes and ownership.

The study was undertaken in the belief that a first requisite for intelligent action on our peacetime production problems is an understanding of the nature and strength of the forces that have shaped the course of agricultural production in recent years. These forces will continue to influence production in the years to come. But new forces will be injected. Some of these are already on the horizon--the mechanical cotton picker is an example. Others cannot be foreseen. But constant change must be expected; and agriculture must adapt itself to changes that are inevitable and, for the most part, desirable.

Revolutionary changes in farm production have taken place in the last quarter-century. Policies developed for the present and for the prospective production situation need to look forward in the light of recent developments and of those which can now be foreseen. They cannot be fashioned from the pattern that prevailed before the age of mechanical power and before other fundamental changes had taken place.

The background data used for this analysis are largely the statistics contained in the crop and livestock reports and other production releases of the Bureau of Agricultural Economics.

Many workers participated in this study. Several reports were released that deal with changes in specific commodities, or with other segments of the war and interwar changes in farming. Basic to this summary report is the special study reported in Farm Production in War and Peace, by Glen T. Barton and Martin R. Cooper, issued by this Bureau. Others who worked on specific parts of the study are: Neil W. Johnson, C. W. Crickman, Carl P. Heisig, E. L. Langsford, Donald B. Ibach, Olav Anderson, R. D. Jennings, S. W. Mendum, E. G. Strand, Weber Peterson, W. D. Goodsell, R. W. Jones, J. R. Ferrell, E. R. Ahrendes, L. Jay Atkinson, R. W. Hecht, A. P. Brodell, and Della E. Merrick who assembled and helped to prepare materials for the entire project. Paul L. Koenig, R. K. Smith, and the late J. B. Shepard were especially helpful in appraising background data.

CHANGES IN FARMING

By Sherman E. Johnson, Agricultural Economist

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SIGNIFICANCE OF RECENT CHANGES

Farmers achieved a remarkable production record in the war years. The increase in total farm output from 1935-39 to 1944 was twice as large as during the entire period from 1919-23 to 1935-39. This wartime record was accomplished without significant expansion in the acreage of cropland, and despite insufficient supplies of labor, machinery, and other materials.

The output of farm products available for human use for the 3 full war years 1942-44 averaged 128 percent of the prewar years 1935-39. In 1946 the level was 133 percent of prewar--an all-time record. Despite a short corn crop the output in 1947 averaged about 130 percent of prewar. If the corn crop had been as large as might have been expected with average weather the total output in 1947 would have been about 132 percent of prewar (fig. 1, page 69). 1/

This tremendous increase in output constitutes an unprecedented break from previous trends. Usually changes in farming develop very slowly. They are often unnoticed until the record over a period of years is examined. Even such major innovations as the tractor and complementary machines adapted for mechanical power were introduced so gradually that they escaped special attention until their cumulative effects became unusually pronounced.

Sometimes extremely favorable or unfavorable weather brings large year-to-year changes in production. For example, 1934 was a year of catastrophic drought, and farm production was much lower than in the preceding years. In 1942, growing conditions were unusually favorable. In fact, consistently good weather was experienced in the 3 war years 1942-44 compared with the average of the years 1935-39. But those prewar years reflect weather conditions that were less favorable to farm production than is the expectancy over a period of years. On the other hand, the factors of weather affecting farm production in 1942-44 were more favorable than longer-time expectancy. But many forces other than weather influenced the level of farm production in both periods.

Considering the average of the years 1942-44, it appears that about one-fourth of the total increase in production can be accounted for by weather conditions that were more favorable than in the prewar years 1935-39. This means that with normal weather farm output in 1942-44 would have averaged about 120 percent of 1935-39.

Obviously then, only a rather small part of the wartime increase in production can be explained by favorable weather. And it follows that a return to average weather conditions alone would not bring a return to prewar production levels. Extremely unfavorable weather would reduce output temporarily. But agriculture experienced a production revolution during the war years, and a large part of the change is irreversible. It will persist under peacetime conditions. To understand what has taken place it is necessary to analyze what happened in the war and early postwar years, to compare this experience with the record in World War I, and to trace the foundation for wartime increases that was laid in the interwar years.

1/ For a detailed explanation of how this index measure of production is constructed see "Farm Production in War and Peace," by Glen T. Barton and Martin R. Cooper, U. S. Department of Agriculture, Bureau of Agricultural Economics, 1945. (F.M. No. 53, mimeographed)

The War Years

War and wartime needs for food, and the doubling of the prices received by farmers for their products, furnished the driving force for increased production, but a combination of favorable physical circumstances made the large-scale increase possible. Potential production capacity had been built up over a period of several years previous to the outbreak of World War II. This increased capacity had its origin in several factors, and each contributed to the increased wartime output. By a fortunate conjuncture of circumstances progress in mechanization, greater use of lime and fertilizer, cover crops, and other conservation practices, use of improved varieties, a better balanced feeding of livestock, and more effective control of insects and disease had all gathered momentum over the several years preceding World War II. Their current effects were obscured by the drought and depression of the 1930's, but developments had reached a stage where these improvements could be effectively combined and used in an all-out production effort. The result was an unprecedented production increase.

The joint effects of these technological improvements on the volume of production may be illustrated by comparing them with the effects of the flow of water in its several tributaries on the water level of a large river. If water rises to flood stage in one of the tributaries this will of course increase the water level in the main stream, but if the tributary is small the effect may be scarcely noticeable when its flood reaches the main channel. Similarly, the effect of single improvements in farm production, that are important by themselves, are scarcely perceptible in their effect on total production. But if all the tributaries of a large river reach flood stage at the same time, the water in the main channel also rises to flood stage, and the change in the water level does not escape notice. In a sense this is the effect that adoption of the accumulation of technological improvements had on farm production in the years of World War II.

But one might make the comparison somewhat differently, and more correctly, by saying that the production-increasing potentialities of improvements that were made over a decade, and that normally would have been diverted gradually into the production stream, were held back by the drought and depression of the 1930's. It was the breaking of these restraints that caused the flood of production in the war years--in the same way that a simultaneous breaking of dams on several tributaries will cause a river to reach flood stage from water that was accumulated from a normal flow at the source.

This accumulation of potential increases in production had escaped notice. The increase that was achieved was therefore much larger than could have been forecast from past trends. It was much greater than the expansion that took place in World War I, because there was no similar accumulation of potential improvements at that time. Perhaps none familiar

with the South would have been so rash as to forecast, in the fall of 1941, that the acreage of peanuts picked and threshed in 1942 would be 177 percent of 1941, and that production for the years 1942-44 would average 175 percent of 1935-39. Likewise, none from the Corn Belt would have dared to forecast in 1941 that the production of soybeans harvested for beans in the years 1942-44 would be 338 percent of the production in 1935-39. Figure 2 shows the average 1942-44 production compared with prewar for some products in which major changes occurred. An optimistic advance estimate of wartime production probably would have averaged less than half of the increase that actually was achieved.

Mechanization is the most important factor back of the increased output of farm products for human use. The number of tractors on farms gradually increased from less than 250 thousand in 1920 to nearly 2½ million in 1945. Use of mechanical power and complementary equipment usually means more total production, but its most important effect is that a much larger share of the product goes to market. As mechanical power is substituted for draft animals, the land formerly used for horse and mule feed becomes available for producing commodities for human use. The shift to mechanical power from 1918 to 1945 made available about 55 million crop acres, or about 15 percent of the available cropland, for the production of marketable commodities. In World War I this large area of cropland and millions of acres of pasture had to be used for producing feed for horses and mules.

Greater use of fertilizer and lime is another influential factor in the wartime increase in production. Measured in plant nutrients (N, P_2O_5, K_2O), the total consumption of commercial fertilizer in 1945 was 97 percent above the quantity used in the prewar years 1935-39. Application of liming materials was over three times as large as in the prewar years. Based on estimates of additional output from increased use, it appears that the increased production resulting from the additional use of lime and fertilizer in 1945 accounted for about 15 percent of the total increase in output since 1935-39.

Crop improvements were another notable source of increased output. Use of hybrid seed increases the yield expectancy of corn about 20 percent; it added about 400 million bushels to the 1944 corn crop. New varieties of oats adapted for use in the Corn Belt and Lake States, and rust-resistant improved winter varieties for the Southern States, were widely adopted in the more recent war years. Continued progress also was made in shifting to the more productive and more nutritious legume hays.

Total land used for intertilled crops increased by about 6 million acres, or 4 percent, from 1935-39 to 1944. Meanwhile the total cropland used for crops increased about 9 million acres, or 3 percent. This is a rather small change and is therefore a minor factor in increased output.

The building up of both livestock numbers and feed supplies in the years immediately preceding the war, and in 1942, made possible later marketings of livestock and livestock products especially in 1943 and 1944. Livestock production was increased also by the feeding of accumulated supplies of wheat, and of some imported wheat and feed grains. However, feeding of both the accumulated supplies and the larger imports accounted for only about 10 percent of the total concentrates fed to livestock in the year ended October 1, 1944. Thus by far the largest proportion of the livestock output came from current production of grain, forage, and pasture; and from an increase of more than one-half in oilseed meals for livestock feed.

Fortunately there were no major outbreaks of either plant or animal diseases or of insect damage in the years of World War II. That no livestock diseases reached epidemic proportions despite record-breaking inventories of livestock was not only good fortune; it was an indication of the effectiveness of modern control methods, and of the vigilance of both farmers and technicians in controlling sporadic outbreaks. Insect damage was held to low levels despite shortages of such important insecticides as rotenone and pyrethrum.

With financial and patriotic incentives as encouragement, and with education and persuasion centered on virtually all-out production of strategic products, farmers and their families worked long hours and often utilized, to the best of their knowledge, every possible means of increasing output. Their efforts bore fruit so well that, even though about one-fourth of the food output went to military and other war emergency uses, there was food enough in 1944 and 1945 to provide our civilians with a per capita food consumption 12 to 14 percent higher than took place in the prewar years, 1935-39. In somewhat different terms, the output of food in 1944 was enough to feed about 50 million more people than were fed by the average quantity produced in 1935-39, assuming the same dietary levels for both periods.

That more people could be fed resulted partly from a change in the production pattern--more oil crops, beans, and peas, and less cotton--and from a more complete utilization of the output. But the shifts in production, (fig. 2), that were necessitated by war needs, made increases in the total volume of production more difficult. Production per acre or per animal is usually lowered when a product is grown on land that is less suited for its production, or by growers who have insufficient experience.

The wartime increases in production were achieved with a constantly shrinking labor supply. The total farm population dropped from 30 million in 1940 to 25 million in 1945. Figure 3 shows the downward trend in farm employment and the contrasting sharp upward trend in production per worker.

In 1944 farmers had 8 percent fewer workers than in 1935-39. Many of the hired workers that were available did not have the strength and skill that are usually considered necessary for farm work. If this fact is considered, it is possible that the per worker effectiveness of the hired workers was not much more than 85 percent of prewar. But farmers and their families worked longer hours and, somehow, the job was done.

Figure 4 shows the changes in production per acre in relation to the changes in acreage of total cropland. The effects of all the forces that have resulted in higher production per acre are combined in this index. Similarly, the line showing production per animal unit of breeding livestock, in figure 5, combines into one summary figure all the forces that have increased livestock production per animal. It shows the trend in production per unit of breeding stock. The shift to mechanical power and the increase in production per acre have made it possible also to increase the number of animal units of productive livestock. Thus the total increase in livestock production is derived both from larger numbers of breeding stock and from the higher output per unit of breeding stock as shown in figure 5. On the other hand, figure 4 shows that increased crop production is largely the result of higher production per acre because changes in the acreage of cropland have been relatively small.

The increased output per acre and per animal, combined with mechanization, made possible the higher output per worker. The three series--production per acre, per animal, and per worker--summarize the startling changes that have taken place in farming since the years of World War I.

During the time that progress in technology has increased output per man so tremendously in agriculture, the same phenomenon has occurred in industry. Figure 6 shows a somewhat more rapid increase in production per worker in the manufacturing and mining industries than in agriculture; but if data were available for the service industries they probably would show a less rapid climb. Increases have occurred in all sectors, however.

This poses a key question for the postwar years. Can peacetime industry and service occupations expand sufficiently to absorb at satisfactory wage levels (1) the workers currently displaced by technological progress in both agriculture and industry and (2) the net supply of new workers (after allowing replacements for death and retirement) that enter the labor market each year? This is a crucial question. But before it is discussed in relation to peacetime agricultural production it is necessary to examine our wartime and early postwar records more closely. And first of all, it seems desirable to compare changes in World War II with those in World War I.

Recent Wartime Increases Compared with Changes in World War I

World War I followed a period of expanding agriculture, but the markets for farm products had caught up with the expanded production before that war started in Europe in 1914. The export market had been large and profitable over a period of years, and the increasing population in this country had gradually absorbed a larger proportion of the total farm output. Machinery suitable for use with animal power was fairly well stabilized. Tractors were only in the early stages of adaptation for farm use. Most of the good virgin lands had been occupied before the advent of the war. Criticisms of the high cost of living with special reference to food and fiber were being heard in the cities. A back-to-the-land movement was advocated by many people. Some of the current literature emphasized the importance of increasing output per acre in view of the fact that little new land was available for settlement and exploitation. 2/

Price and income incentives in World War I were favorable to output expansion. Taking the years 1910-14 as a base, prices received by farmers for farm products in 1918 were 204 percent of those prewar years. By 1919 they were 215 percent. Prices of products bought by farmers also increased during the war, but at slower rates; and in 1918 and 1919 net incomes to farm operators reached new high levels. But with financial and patriotic incentives similar to those of World War II, and with the need for food just as urgent, the volume of output for human use increased only about 5 percent from the prewar years 1910-14 to 1918-19.

What are some of the reasons for the differences in production increases in the two war periods?

Although the most productive virgin lands had been brought into cultivation by the beginning of World War I, some new land was available for exploitation. Harvested cropland increased more than 32 million acres from the years 1910-14 to the years 1918-19. This is more than twice as large an increase in harvested cropland as occurred from the prewar years 1935-39 to the war years 1942-44. It should have resulted in greater output at that time if other factors had been favorable.

The foods receiving most emphasis in World War I were wheat and meat. In World War II there was much less emphasis on wheat until after the end of hostilities, and relatively more on oil seeds, beans, and peas; and on meat, eggs, and dairy products. The products emphasized in World War II were new products on many farms, so increases were somewhat more difficult to achieve than increases in the products that are normally produced.

2/ See Farmers' Bulletin 406, "Soil Conservation" by W. J. Spillman, 1910.

Wheat acreage in World War I was increased on new lands in the drier wheat-producing areas and it was substituted for other crops on the older lands of the humid areas in the Corn Belt and the Eastern States. The acreage of wheat harvested in the five major Corn Belt States in the years 1917-19 was 129 percent of the 1910-14 figure. A new peak of harvested wheat acreage in the United States was reached in 1919 with 73.7 million acres.

Cattle numbers were at the low point of a cycle before the beginning of World War I in 1914, and steps were taken to encourage expansion of cattle production, both on eastern farms and on the ranges of the Western States. The Forest Service was requested to increase the numbers allowed under grazing permits in the national forests. Under the stimulus of high prices and other incentives, cattle numbers on January 1 increased from a low of 56 million in 1912 to a high point of 73 million in 1918. For World War II the high point in cattle numbers was reached January 1, 1945 with 85.6 million on farms and ranches. But in comparing the two periods one must recall that the decrease in horse and mule numbers had released land equivalent to the acreage needed for maintaining 16.5 million head of cattle and calves.

Hog production was stimulated in World War I, partly by a promise to maintain prices of hogs at a fixed ratio to corn at Chicago. In 1919 the number of all hogs on farms January 1 had increased 21 percent--from 53 million in 1914 (a low point in the hog cycle) to 64 million. In World War II, numbers on January 1 increased 68 percent from 50 million in 1939 to a high point of 84 million in 1944.

Despite the emphasis on wheat and meat in World War I, and the substitution of these products for other products in the farm economy, wheatless and meatless days were proclaimed. Adequacy of basic food supplies remained a critical war problem.

Weather was not so favorable during the years of World War I as in World War II. The wheat crop of 1916 was reduced by adverse weather and damage by black stem-rust. In 1917 the crop was even smaller than in 1916 because of severe winter killing of winter wheat and of drought in some spring-wheat areas. Carry-over reserves were badly depleted by exports to Allied Nations. The wheat crops were nearly a third larger in 1918 and 1919 than in 1917, but these gains in production became available chiefly after the end of the war.

Although manufacture of farm machinery was not limited by Government order as in World War II--in fact, its manufacture was encouraged until the fall of 1918--mechanical power was still of minor importance. Tractor power contributed only 2 percent of the combined work-animal and tractor-power units on farms, in 1919. Farming largely with animal power meant

that much land which now produces marketable products was needed for horse and mule feed, and that reserve power for long hours of field work, and for timeliness of operations, was not available.

Because potash fertilizers had been imported from Germany, there was a serious shortage of this plant nutrient during World War I. The available supply in 1918 was only about one-fourth of that used annually in the immediate prewar years. Nitrogen supplies were also short. In fact, total use of fertilizer was considerably reduced in the early part of that war and, although it increased somewhat in 1918-19, it did not reach the levels of 1914 at any time during those war years.

Plant and animal diseases and insect pests took a proportionately greater toll of potential production in World War I than in World War II. The boll weevil caused extensive damage to cotton in all of the years of the first war. Black-stem rust seriously affected wheat production in 1916. Outbreaks of hog cholera were numerous from 1911 to 1915 and again in 1919.

The situation in World War I as compared with World War II can be summarized in this way. More sod land that could be broken up and put to use was available but on the intensive side (increases in output per acre and per animal) production was limited by shortage of fertilizer, lack of mechanical power, damage by plant and animal pest and disease, and somewhat unfavorable weather. There were no innovations such as hybrid corn that could be seized upon to increase production quickly. The background of agricultural research was more limited, and organized extension teaching was in its early stages in most States. In other words, the same favorable conjuncture of circumstances that prevailed in World War II did not develop in World War I.

It should be emphasized that, aside from weather, all of the physical conditions more favorable to increased production in World War II have grown out of invention and research, and have been spread by the education and operations program of the interwar and World War II years. The cumulative value of agricultural research and of extension teaching in making possible the increase in farm output in World War II can hardly be overestimated. And the stimulation given by operations programs to conservation practices and increased use of fertilizer must not be overlooked.

The Early Postwar Years

The record now includes the first 2 production years following the end of hostilities. During these years the pressure on supplies of food grain intensified, and wheat again took first place in meeting the food needs of hungry people.

In view of the urgency regarding food relief it was fortunate indeed that growing conditions in this country were exceptionally favorable for both food and feed grains in 1946. Wheat and corn production made new records. In 1947 the wheat crop exceeded even the high record established in 1946; the total outturn was 1.4 billion bushels. But the corn crop was nearly a billion bushels smaller than in 1946. The relative shortage of feed grains severely limited livestock production for 1948.

Farm prices moved upward rapidly in 1946 and 1947; and in December 1947 they were almost 3 times as high as the prewar years 1935-39. Prices paid for goods used in farm production also climbed rapidly--to twice their prewar level in December 1947. The margin between costs and selling prices was favorable to most producers, however, and net incomes to farm operators reached successive peak levels in 1946 and 1947.

Income incentives to high-level production were good in both 1946 and 1947. And more farm labor was available than during the war. The farm population was 27.6 million January 1, 1947 compared with 25.2 million in 1945; and farm employment averaged 93 percent of 1935-39 in 1945. More farm machinery and more commercial fertilizer were available than during the war, although supplies were not sufficient to meet all demands.

If supplies of production goods become much more adequate than they were during the war and if income incentives are quite favorable, are we likely to see a further increase in output in the next 3 to 5 years? Or are we now on a high plateau with greater prospects of a downward slide than of a further rise? These are vital questions in view of the exports of food projected under the European Recovery Program. They become extremely important if we do not make rapid progress toward a stable peace.

Output may average lower in 1948 than in 1947 because of the shortage of feed grain caused by the short corn crop in 1947. This indicates that the potential effects of weather on farm output cannot be over-emphasized. If we should have a drought disaster, as 1934, the output might drop as much as 20 percent in any one year. Moreover, such a disaster would necessitate the selling of breeding livestock which would affect output in later years.

But given average weather and sufficient time to make the changes that would be necessary in the farm-production plant the only practical limit to our farm output would be the labor and the capital that we consider profitable or necessary to use in agricultural production. And this depends largely upon decisions of individual farmers, which in turn

are based upon their confidence in continued prosperity. Even over so short a period as 3 to 5 years production can be increased considerably. If farmers could count on a continued favorable relationship between gross returns and farm costs they could afford to make many investments that would increase output and reduce costs per unit. The methods for increasing output are known, but farmers would have to be convinced that they would pay over a period of years. The opportunities for further increases in production are largely those that were developed in the interwar years. But some improved techniques are of recent origin.

If a stable peace is achieved, and the food emergency gradually subsides, farmers will need to begin the transition toward peacetime production. Changes are likely to be needed in the direction of raising less wheat, corn, and soybeans, with more emphasis on hay and pasture in the interest of conservation, and on producing more meat and milk.

FOUNDATION FOR INCREASED PRODUCTION

An examination of production changes in the interwar years clearly indicates that the foundation for the wartime and early postwar increases in production was built up in the 20-year period between the two World Wars. It was built on the tremendous improvements that have been made in mechanization, in land use, in conservation, fertility, and cultural practices, in development of new crops and new varieties, and in increasing the efficiency of livestock production.

The cumulative effect on the total volume of production was not realized at that time because of drought and because markets were not available for larger quantities of farm products. We have seen that although farm output increased slowly during the 1920's, it dropped precipitously during the drought of the early 1930's (fig. 1). Later production reached its new peak in 1937 and remained relatively high in 1938 and 1939.

Except for the severe drought years, farmers obviously could have produced more in the 1930's if markets had been available at prices profitable to farmers. But despite the brake placed on increases in production by the low prices and resulting crop-adjustment programs, it seems evident that the total volume would have risen sharply in the early 1940's even without the incentive of wartime prices and needs. The production potential was built up in the late 1930's to the point where accelerated increases in production were almost inevitable.

The stimulation of war needs--the patriotic urge to increase production, the doubling of farm prices, and the tripling of net incomes to farmers--pushed production faster and farther than it would have gone under peacetime conditions. But this greater acceleration was physically possible only because of the foundation that had been laid in the interwar years.

Changes in the Use of Farm Machines

The rapid shift from animal power to mechanical power for farm production in the interwar period constituted one of the most important changes that has ever taken place in American agriculture. It was a cornerstone in the foundation for increased production.

One result of this change was a transfer of resources from the production of power on the farm to the production of livestock and crops for sale in the market. This transfer released about 55 million acres of cropland for the production of marketable farm products. That, of course, is the most startling effect that mechanization has had on American farms.

But other effects are also striking. The shift to mechanical power and complementary equipment brings an increased output per worker both by enabling him to do the job faster and by doing a better job of tillage or other operations and in that way realizing more benefit from other improved practices. The physical burden of farm work is lessened because the drudgery of hand labor is eliminated. Fewer workers are needed in farm production. Physical strength becomes relatively less necessary, and mechanical skill becomes more necessary in the performance of farm work.

The effects of the greater timeliness in farm operations that is possible by mechanization are difficult to measure, but obviously the result is both greater total production and higher quality of farm products. As power equipment can cover more acres per hour and can be used longer hours if necessary, it has enabled farmers to do critical jobs without the delay that frequently occurred when horse equipment was used. For example, the quick coverage possible in spraying potatoes with a multiple-row power sprayer may salvage a crop that otherwise would be seriously damaged.

Perhaps the best illustration of the contribution of mechanical power to timeliness of operations is the experience in the Corn Belt with unfavorable weather at planting time in each of the years 1943 to 1945 and again in 1947. The spring of 1943 was exceptionally wet, so planting was seriously delayed in many areas. Illinois usually receives 4.10 inches of precipitation in the month of May, but in 1943 it had 8.75 inches that month--more than twice the average rainfall. Rainy weather prevailed throughout the month and so retarded field work that only about 15 percent of the corn had been planted at the end of May, when planting is usually completed.

With a tractor and power equipment 3 acres of land can be prepared and planted to corn during the time that 1 acre is planted with work animals. If the tractor is put on a 24-hour schedule, which is not feasible with work animals, the preparation and planting job can be done

seven times as fast as with animal power. By utilizing all available mechanical power and equipment (sometimes on a 24-hour schedule) farmers were able to complete their preparation of land and planting of corn in record time during the early days of June, in 1943. It was estimated that 85 percent of the corn was planted by June 15.

If tractor power had not been available some of the corn would never have been planted because the job could not have been done before it was too late to obtain a crop that year. Tractor power saved the day and, with favorable weather during the rest of the season, Illinois produced 419 million bushels of corn, one of the largest crops on record.

Weather conditions similar to those experienced in 1943 prevailed in many areas of the Corn Belt in 1944 and again in 1945, yet the yields were large. The late wet spring in 1947 also delayed corn planting, but this was followed with a late-season drought, and the combined result was a short corn crop. It is apparent that the contribution to production of greater timeliness is one of the real benefits of mechanization, even though it is difficult to measure in quantitative terms. But the experience in 1947 also indicates that it does not furnish adequate insurance against drought.

The rate of adoption of mechanical power and auxiliary equipment has varied considerably in different periods. The number of tractors on farms increased sharply during World War I, despite the fact that these tractors were cumbersome, slow moving, and expensive to operate (fig. 7). They were adapted only for the heavy tillage and harvesting and for belt work. Farmers had to keep work animals for other farm operations, which meant a considerable duplication of power. After 1920, the rate of increase in tractors on farms slowed down for 2 or 3 years, until the general-purpose tractor was introduced. That was suitable for the cultivation of row crops and for other farm tasks as well as for the tillage and harvesting work.

This revolution in tractor design, along with improvements that were made in standard wheel tractors and crawler tractors for heavy operations on large farms, brought a considerable spurt in tractor purchases, and a rapid increase in tractors on farms from 1925 through 1930. The numbers increased only slowly from 1930 to 1932 and in the drought and depression years of 1933 and 1934 actually were below the 1932 numbers. With the beginning of the agricultural recovery in 1935, the number increased very rapidly. The sharp upward climb has continued since that time; although war limitations on the manufacture of tractors slowed down the rate of increase, especially from 1943 to 1944. But the numbers on farms increased each year during the war, and on January 1, 1945 they totaled 2,422,000. The estimated number on January 1, 1947 was 2,800,000.

Introduction of rubber tires for tractors and complementary equipment during the 1930's started a rapid and steady advance. It greatly facilitated the use of tractor power for many farm tasks and lowered the cost of tractor operation. Perhaps an even more valuable development in the 1930's was the redesigning of farm machinery for use with tractor power. When tractors were introduced, the machinery that had originally been designed for use with horse power was adapted to tractors by making special hitches and some other minor changes. The complete changes in design of equipment to facilitate use with tractor power have come only within the last few years.

In summary, the three most important technical developments that stimulated mechanization in the interwar years were: (1) Introduction of the general-purpose tractor adapted for use on smaller farms and for a wide variety of farm jobs, (2) use of rubber tires for tractors and other machines, and (3) design of equipment for use with tractors. These developments accelerated the shift to tractor power and stimulated the adoption of combines, corn pickers, and other tractor-drawn machines. Improvements in construction of both tractors and complementary equipment have enabled farmers who are relatively unskilled at mechanical work to operate power equipment without serious disadvantage.

Substitution of tractors for horses and mules has not taken place at uniform rates over the entire country. Figure 8 shows, by regions, the number of tractors on farms in 1920, 1930, 1940, and 1945. That the rate of adoption has been more rapid in the Corn Belt, the Great Plains, the Mountain, and Pacific States than in the East and South is evident. Figure 9, showing the distribution of tractors on farms in 1945, indicates the relatively greatest concentration of tractors in the Midwest and in smaller areas in other parts of the country. Table 1 shows the number of tractors per 100 acres of total cropland, by census geographic divisions, in 1920, 1930, 1940, and 1945. This table indicates that the Northeastern States are relatively well supplied with tractors in relation to cropland. But the average acreage of cropland per farm is less there than in the Midwest, and the number of tractors per 100 farms in the New England States in 1945 was only about half the number for that many farms in the West North Central States.

The Southern States, excluding Oklahoma and Texas, were far behind the rest of the country in the shift to tractor power up to the beginning of World War II. But purchasing power in the South was built up during World War II, and labor shifted heavily to nonfarm work. Both of these facts accelerated the purchase of tractors and complementary equipment. Table 2 shows the consequent upward spurt in tractor numbers in the Southern States from 1940 to 1945 and 1947. In the Southeastern States there were nearly 3 times as many tractors on farms in 1947 as in 1940. And in the 16 Southern States tractor numbers increased about 123 percent in those years, as compared with an increase for the entire country of 81 percent.

Table 1.- Number of tractors per 100 acres of total cropland 1/, by geographic divisions, 1920, 1930, and by years 1940-45

Geographic division	1920	1930	1940	1941	1942	1943	1944	1945
New England	0.05	0.36	0.76	0.92	1.00	1.17	1.20	1.34
Middle Atlantic	.08	.56	.91	.98	1.07	1.22	1.29	1.40
East North Central	.09	.43	.77	.82	.92	.98	1.00	1.04
West North Central	.07	.22	.40	.42	.47	.51	.50	.53
South Atlantic	.03	.17	.21	.26	.28	.35	.39	.49
East South Central	.02	.09	.15	.18	.20	.25	.28	.36
West South Central	.04	.12	.29	.31	.37	.42	.46	.52
Mountain	.08	.17	.28	.31	.35	.39	.38	.41
Pacific	.11	.34	.49	.54	.58	.63	.67	.75
United States	.06	.24	.42	.46	.52	.57	.59	.64

1/ Includes acreages from which one or more crops were harvested, and acreages of crop failure and summer fallow.

* * * * * *

Table 2.- Number of tractors on farms, January 1, 1940, 1945, and 1947

Region 1/	Jan. 1, 1940	Jan. 1, 1945	Jan. 1, 1947	Percentage increase from 1940-47
	Thousands	Thousands	Thousands	Percent
Appalachian	64.3	133.4	159.6	148.
Southeast	29.0	67.0	86.8	199.
Mississippi Delta	32.1	65.2	78.4	144.
Southern Plains (Oklahoma and Texas)	142.2	232.8	271.6	91.
Total, 16 Southern States	267.6	498.4	596.4	123.
United States	1545.	2421.7	2800.	81.

1/ The following States are included in each region. Appalachian: Maryland, Delaware, Virginia, West Virginia, Kentucky, Tennessee and North Carolina; Southeast: South Carolina, Georgia, Florida and Alabama; Mississippi Delta: Arkansas, Mississippi and Louisiana; Southern Plains: Oklahoma and Texas.

Continued rapid shift to tractor power can be expected on Southern farms. The new small tractors are well adapted to small farms and rolling land. And farmers are learning how to use power equipment to advantage.

The number of tractors on farms will also increase in other areas, and by 1950 there probably will be more than 3½ million farm tractors in use in this country. As the tractors increase the over-age horses and mules will be disposed of. There were only 9.2 million horses and mules of all ages on farms January 1, 1948 compared with 14.5 million in 1940. The colts that are being raised are not enough to maintain horse and mule numbers of working age at present levels. Further reductions in horse and mule numbers will release additional land for the production of marketable products.

In considering the importance of mechanical power on farms one must not forget the use of automobiles and trucks to speed up the transportation job both on the farms and from farms to market. Figure 10 shows the increase in numbers of trucks and automobiles, 1910-48. It is apparent that automobiles and trucks on farms have increased in about the same way as tractors, except for larger dips in the depression years of the early 1930's, and for a shrinkage in the numbers of automobiles during the war years.

Wartime scarcity of labor stimulated the attempts by farmers to buy more and more labor-saving equipment. Limitations on the manufacture of tractors and other farm machines held down the rate of farm mechanization, but there were notable increases in labor-saving equipment on farms during the war. For example, the number of tractors on farms increased 57 percent from 1940 to 1945. In the same period the number of grain combines increased 97 percent; corn pickers, 53 percent; and milking machines, 117 percent (table 3). If more new machinery had been available during the war the process of mechanization would have been more complete, especially in the Southern States, and farm output would have gone even higher, or more workers could have been released for war industry.

With removal of the wartime limitations on manufacture of machinery farmers stepped up their purchases of all types of farm equipment. And although more machinery was manufactured for domestic use in 1946 and 1947 than in any prewar year, farmers would have bought a much larger volume if it had been available. Tractors, combines, corn pickers, grain elevators, pick-up hay balers, and heavy disks were among the machines that were in short supply in relation to farmers' desire to buy them.

Annual purchases of farm machinery are usually closely related to net farm incomes. It is not surprising, therefore, that demand for new machinery was high in both 1946 and 1947. Investment in new machinery in good years is one way of building up capital reserves to carry over the years of lower farm incomes. Other accelerating factors in the demand for

Table 3.- Number of tractors and other specified machines on farms, United States, January 1, 1910-47

Year	Farm tractors	Farm motor trucks	Farm automobiles	Grain combines	Corn pickers	Milking machines
	Thousands	Thousands	Thousands	Thousands	Thousands	Thousands
1910	1	0	50	1	-	12
1920	246	139	2146	4	10	55
1930	920	900	4135	61	50	100
1940	1545	1047	4144	190	110	175
1941	1/ 1675	1/ 1095	4330	225	120	210
1942	1885	1160	4670	275	130	255
1943	2100	1280	4350	320	138	309
1944	2215	1385	4185	345	146	345
1945	2422	1490	4152	374	168	379
1946	2585	1550	4150	415	200	450
1947	2800	1730	4400	450	225	2/

1/ 1941-44 data are revised estimates of Bureau of Agricultural Economics, adjusted to census numbers; 1945 numbers are from census report. 1946 and 1947 are estimates.

2/ No estimate available.

farm machinery in 1946 and 1947 were the high farm-wage rates and the favorable experience during the war years with the new labor-saving machines.

Although farmers are likely to continue heavy purchases of farm machinery under favorable conditions of income, manufacturers' supplies will soon be adequate to meet farmers' demands, unless there are serious interruptions in the flow of raw materials to manufacturers.

Farm use of central-station electric power expanded rapidly, even during the war. From 1941 to 1945 there were more than 650,000 new installations on farms. At the end of the year 1946, over 57 percent of the farms in this country had central-station electric power, compared with 26 percent in 1940 and 9 percent in 1930. Figure 11 shows the percentage of the total number of farms in each State that had central-station electric power in December 1946. It is expected that many more farms will be electrified within the next 5 years. Use of electricity in farm production is mainly as a source of stationary power around the farmstead, but the contribution of electric lights and heat to the production of poultry and hogs and to some other enterprises should not be minimized.

Home uses of electricity are of major importance. Electric power for lighting the home and for cooking, washing, ironing, and other household work lightens the workload for the housewife. And such home equipment as refrigerators and deep-freeze units supplement farm production by providing for better utilization of farm products, both for home use and for sale.

The impact of mechanical power and complementary equipment on the transformation of agricultural production in the interwar, war, and early postwar years may well be compared with the agricultural revolution that followed the introduction of improved machinery for use with animal power. The steel plow, the mower, the reaper, and later the self binder, were the primary developments in the animal-power phase of mechanization, which began about 1830 and was well stabilized by the beginning of World War I. The mechanical-power phase had then begun, but it did not gain full momentum until that war was over, and the really noteworthy effects have come in recent years.

In fact, the mechanical-power phase of farm mechanization has not yet been stabilized. Wheat production is almost completely mechanized and corn production is well on the way in the main producing areas. Hay harvesting is in a state of flux, with several radically different methods competing for adoption in all the chief hay-producing areas. Mechanization of the cotton harvest is only in its beginning stages, and tobacco is

still a hand-labor crop. Considerable progress had been made in labor-saving equipment for the dairy enterprise but relatively less attention has been given to improvements in housing and other equipment for the livestock enterprises than for crop production. Advances in this domain give promise of yielding substantial savings in capital investment as well as in the labor used.

A look at the new mechanical developments that are already on the horizon leads to the conclusion that the new impacts of mechanization on agricultural production will be just as influential in the decade 1948-57 as were those of the preceding decade. Two of the major developments will be the increase in number of tractors, especially the small sizes fitted with equipment suitable for use on small farms; and the fairly rapid adoption of mechanical cotton pickers. These developments, along with many others, will have far-reaching repercussions on production and on the number of workers that will be needed in agriculture.

Changes in Land Use, Conservation, and Rotation Practices

Many changes in the use of cropland and permanent pasture took place between the World Wars. In the early part of this 20-year period the rather extensive abandonment of land in the Eastern States was offset by the development of new lands in the Western States. Total cropland acreage in the United States was a little lower in the early 1920's than in 1919, but it rose slowly from 1927 to 1931 (fig. 12). From 1932 to 1939 the trend was downward. Total cropland remained at about the low point reached in 1939 until the war year of 1943; then the total increased to within about 1 percent of the 1928-32 peaks.

Acreages of harvested cropland have been more erratic (fig. 12). The effects of the droughts of 1934 and 1936 are especially apparent. The drought's impact was most severe in the Great Plains and Intermountain States, where much of the sod land that had been broken out in the 1920's was abandoned in the 1930's. Some of it was again brought into use during the war, and by 1947 much more of the land formerly in cultivation was back in crop production. There was also new breaking of native sod lands that over a period of years are best suited for permanent pasture.

Changes in harvested acreages of principal crops in the Great Plains, the Mountain, and the Pacific Northwest States are apparent in figure 13. These States contain the chief wheat-producing areas of the country. It is evident that "the plow that broke the Plains" broke much of it in the decade following World War I. In these States the crop acreage was considerably lower in World War II than in the years preceding the drought and depression of the 1930's. But the crop acreage rose rapidly in the early postwar years.

Changes in the principal uses of cropland from 1928-32 to 1935-39 and to 1944 and 1945 are shown in table 4. These cropland figures include rotation pasture but do not include wild hay, orchards, vineyards, and farm gardens. It is apparent that the acreage of intertilled crops decreased, while the close-growing crops held about the same level in the years 1928-32 and 1935-39. The acreage in sod crops decreased from 1928-32 to 1935-39 because of drought and loss of seedings. There was a 4-percent increase in the acreage of intertilled crops from 1935-39 to 1944. The acreage of close-growing crops was decreased, but the sod crops (hay, hay and cover-crop seeds, and rotation pasture) more than held their own.

The acreage in intertilled crops dropped considerably in 1945. There was a steady decrease in intertilled crops in the Southern States during the war, chiefly because of reduced acreage in cotton. But until 1945 that decrease was more than offset by the large increases in corn, soybeans, and other intertilled crops planted in the Corn Belt and Lake States.

The total acreage of land used for crops also dropped from 1944 to 1945. Again the downturn is largely accounted for by decreases in the Southern States. The larger wheat acreage is reflected in the somewhat higher acreage of close-growing crops in 1945. By 1947 the planted wheat acreage was 8.8 million acres greater than in 1945 with a large part of the increase occurring in the Great Plains States.

Whenever the needs for emergency food subside somewhat it would be in the interest of permanent agriculture to shift between 8 and 9 million acres of intertilled crops in the Corn Belt and Lake States into hay and rotation pasture. This shifting to sod crops may take place in the next few years, as farmers realize the importance of hay and pasture in a soil-maintaining system of farming. In the humid areas, crop rotations that contain a combination of intertilled, close-growing, and sod crops are more likely to maintain fertility and to sustain high crop yields over a series of years than does single cropping, or a too-great concentration on intertilled crops. Only a part of the evidence of the sacrifice made in postponing crop rotations during wartime is found in the larger acreage of intertilled crops. The five principal Corn Belt States apparently had at least 1.5 times as many acres of intertilled crops that were repeated 2 or more years on the same land as they had in the immediate prewar years. A cropping program designed to maintain soil resources should reduce considerably this succession of intertilled crops.

In many areas of the Great Plains, the Intermountain, and the Pacific States a part of the cropland acreage should be in summer fallow, as a means of storing moisture and of making plant nutrients more readily available. In the wheat areas of the Pacific Northwest the practice of summer fallowing has been followed for more than half a century. In the Palouse area proper, where annual precipitation is 18 or more inches, summer fallow-

Table 4.- Changes in the principal uses of cropland in the United States--
1928-32, 1935-39, 1944 and 1945

Use of cropland	Average 1928-32 1/ 2/	Average 1935-39 2/	1944 2/	1945 2/	Percentage 1945 is of	
					1928-32	1935-39
	Million acres	Million acres	Million acres	Million acres	Percent	Percent
Intertilled crops 3/	176.6	163.0	168.8	157.6	89	97
Close-growing crops 3/	132.6	133.0	129.8	132.4	100	100
Sod crops 3/ 4/	77.3	73.5	80.2	82.5	107	112
Total cropland used for crops	386.5	369.5	378.8	372.5	96	101
Summer fallow and idle cropland	41.3	56.9	47.3	54.4	132	96
Total cropland 5/	427.8	426.4	426.1	426.9	100	100

1/ The data on which the 1928-32 estimates are based are less complete than for later periods.

2/ Planted acres so far as available; all others harvested acres.

3/ Adjustments made for multiple use of land by considering first use in the crop year as the primary use.

4/ Including acres in tame hay, hay and cover-crop seeds, and in rotation pasture.

5/ Includes rotation pasture, but does not include wild hay, orchards, vineyards, and farm gardens.

ing has not been necessary for moisture storage, and dry field peas are now grown on much of the acreage that formerly would have been summer fallowed. Interest in summer fallowing in the Great Plains was not extensive until the early 1920's. It apparently started in Montana, Wyoming, and Colorado, and extended farther east in the late 1920's and early 1930's, under the pressure of recurring droughts.

Accurate estimates of the acreage of summer fallow by States are not available but table 5 is believed to be indicative of the general trend. For the seven Western States the fallow acreage has remained substantially the same since 1928-32. Substitution of field peas for fallow in the Pacific Northwest has apparently been offset by moderate increases in wheat acreage in the drier areas where fallowing is necessary to produce a crop. In the Great Plains States, however, summer fallowing reached a peak of 17.4 million acres in 1939--more than six times greater than the average acreage of the years 1928-32. With increased need for wheat, and with more rainfall, fallow acreage dropped by 1944 to around 11 million acres.

Although no comparable estimates are available for 1946 and 1947, the evidence indicates a further drop in summer fallow of at least 2 million acres. Some reduction of summer fallow was justified as an emergency expedient but widespread resumption of the practice of continuous cropping to wheat would soon result in a smaller total wheat crop. The seedings of wheat for 1947 and 1948 harvests are much too large in the Great Plains and some other dry land areas to expect to maintain that acreage for several years without reducing yields. As to permanent soil damage, we have not yet developed crop rotations in the Great Plains that will maintain the soil. Crop farming in that region is therefore to some extent soil mining. But farmers can avoid many of the weather hazards by summer fallowing, stubble mulching, strip cropping, contour farming, and other practices adopted to specific areas. Return to these practices, however, means fewer acres in wheat, but not necessarily fewer bushels of wheat over a period of years.

Since 1936, payments have been made under the Agricultural Conservation Program to cooperating farmers for each acre of protected summer fallow. In some States the payment was made for ordinary summer fallow, provided the surface was ridged or stubble mulch was left to prevent erosion. In others, strip fallowing across the direction of prevailing winds or on the contour were the only practices recognized for payment. Farmers in most wheat-producing areas of limited rainfall are now convinced of the value of these practices.

In addition to payments for summer fallow the Agricultural Conservation Program has paid cooperating farmers for carrying out a wide variety of soil-building practices in all regions. Among the more important are contour tillage, strip cropping, terracing, and use of green manure and cover crops.

Table 5.- Estimated acreage in summer fallow for selected States and periods

Period	7 Western States 1/	10 Great Plains States 2/	Total 17 States
	Million acres	Million acres	Million acres
1928-32 3/	5.5	2.8	8.3
1939 4/	5.4	17.4	22.8
1942 5/	5.3	14.4	19.7
1943 5/	5.6	12.2	17.8
1944 5/	5.5	10.8	16.3

1/ Washington, Oregon, Idaho, California, Nevada, Utah, and Arizona.

2/ Montana, Colorado, Wyoming, New Mexico, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas.

3/ Based largely on an unpublished study of the Bureau of Agricultural Economics, 1939.

4/ Agricultural Census data for idle and fallow acreage with fallow estimated by applying ratios from rural-carriers survey made for the Bureau of Agricultural Economics.

5/ Estimates of Production Adjustment Committees in each State.

Steady growth is indicated in the adoption of contour operations, the big bulk of which has occurred in the South. Contouring not only lessens the damage from water erosion but is likely to bring increased crop yields, particularly in areas where lack of sufficient moisture tends to limit the production.

Seeding of green manure and winter cover crops are practices that protect against erosion losses, contribute in some instances to the supply of available pasture, and increase crop yields through the return of substantial quantities of organic matter to the soil. They are particularly valuable in the more humid areas where a fall-harvested intertilled crop would otherwise leave the land bare, and subject to soil washing in the winter. As yields are maintained or increased through such practices, their rapid extension has no doubt contributed significantly to total agricultural production. The acreage of winter cover crops in the Southern States was about four times larger in 1944 than in prewar years. Adoption of these practices might have been even greater if larger supplies of the preferred cover-crop seeds had been available.

Terracing has been done most extensively in the South. The rate of construction of new terraces declined moderately during the war. It is possible for a farmer to build his own terraces with simple equipment, but technical assistance is necessary in laying out the contour lines, and much of the earth-moving is done more satisfactorily with heavy mechanized equipment. Using this more costly method may be considered as a capital improvement and, as such, it was delayed by many farmers until after the war. Changes in farming systems in the South which result in a smaller proportion of intertilled crops may permit the development of rotations that will make terracing less necessary in some areas.

Nearly three-fourths of the farms in the United States are now included within the boundaries of Soil Conservation Districts. By the end of 1947 farmers and technicians had jointly developed long-time conservation plans on more than 600,000 of these farms containing about 170 million acres. The principal practices applied on these farms are contour cultivation, terracing, strip cropping, crop-residue management, and grass planting. Not all farmers in Soil Conservation Districts will formulate definite conservation plans. But the farms on which such plans are applied will serve as demonstrations to their neighbors, and conservation practices that prove their worth will spread voluntarily to other farms.

Changes in permanent pasture are much more difficult to trace than changes in cropland. Considerable improvement of permanent-pasture

areas was begun in the middle 1930's and has continued. Liming, fertilization, and establishment of new pasture, are the main improvements in the humid areas. In the range areas attention has centered on stockwater development, reseeding, and rotation grazing.

Relatively favorable weather for forage growth made it possible to sustain a large livestock population on the western ranges during the war and early postwar years. If years of lower precipitation should come it would be necessary to reduce the numbers, but in the areas where major improvements have been carried out the long-time carrying capacity has been increased.

In many humid areas the possibilities for further improvement of permanent pasture are great. It seems probable that much of this improvement will be undertaken in the years ahead--part of it in response to the stimulations furnished by conservation programs.

Changes in Liming and Fertilizing Practices

Use of lime and commercial fertilizer was greatly accelerated in the immediate prewar and war years, and has continued to increase. A considerable part of the larger farm production can be attributed to the greater use of these materials. But of about equal importance is the potential contribution of lime and fertilizer to the establishment of stable and soil-maintaining systems of farming.

Information on use of liming materials is not available for the years before 1929, when the tonnage of lime used was about 60 percent of the 1935-39 level. The tonnage used annually was nearly doubled from 1935 to 1936, the year when lime was first included in the Agricultural Conservation Program. Figure 14 indicates that the use of liming materials in the later was years was nearly three times the prewar levels, despite the difficulties in obtaining labor and trucks for crushing and hauling. In 1946 more than four times as much lime was used as in the years 1935-39.

Annual use of lime will need to be increased even more if all of the land in the humid regions that needs lime for soil-maintaining crop rotations is to receive an initial application, and if adequate maintenance applications are made thereafter. It has been estimated that the tonnage of lime applied annually would need to be about 2.5 times the 1943 level, after all the land needing lime has received an initial application. Before that point, a larger annual tonnage would be needed because the initial application is made at a higher rate per acre in some areas. 3/

3/ See "Peacetime Adjustments in Farming--Possibilities Under Prosperity Conditions," U. S. Dept. of Agr. Misc. Pub. 595. 1945.

On many soils in the humid regions it is necessary to apply lime in order to get full use of commercial fertilizer, especially the phosphates. And lime and phosphate applications are required for successful stands of the legumes and grasses that are so necessary in a good crop rotation, and for soil maintenance. Some of the increase in use of commercial fertilizer is accounted for by the greater use of phosphates in combination with liming materials for hay and pasture improvement in late years. Nearly all the fertilizer distributed by public agencies has been applied on legumes and on hay and pasture lands. But even the relatively large wartime distribution of fertilizer by public agencies accounted for only 10 percent of the total value of the fertilizer that was used.

The increase in consumption of fertilizer is actually an acceleration of a long-time upward trend that was interrupted in the severe depression of the early 1930's (fig. 15). The largest part of the increase has been applied to the cash crops, although a growing proportion of the fertilizer now goes on legumes and grasses.

During the war many farmers who had not previously used commercial fertilizer learned how to use it to increase their production. It was used in areas and on crops where it had not been used before. This experience is likely to mean a much higher level of use in the years ahead. Lower prices for farm products undoubtedly would mean some decrease in purchases of fertilizer for cash crops, but it does not seem at all probable that sales would drop back to prewar levels.

From the standpoint of maintenance of land resources the Nation is vitally interested in the use of lime and fertilizer for the establishment of crop rotations that contain sufficient acreages of grasses and legumes. Greatly increased consumption of lime and fertilizer for this purpose would help to achieve more stable systems of farming, and would lessen the emphasis on those staple cash crops which might press most heavily on market outlets when the food emergency subsides.

State Committees that were studying postwar adjustments suggested that, under favorable price conditions, it would pay farmers to use about twice the quantity of plant nutrients in the form of commercial fertilizer that was used in the war year 1944. 4/ A much larger proportion of it would be used for small grains other than wheat, however, and for legumes, hay, and pasture. These uses would be more than tripled from their wartime levels. If such a program were carried out it would make a substantial contribution to farming stability, and to maintenance of land resources. But these large increases in the use of fertilizer

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4/ See "Peacetime Adjustments in Farming—Possibilities Under Prosperity Conditions," U. S. Dept. of Agr. Misc. Pub. 595. 1945.

would not take place without strong educational and other programs that are designed to accelerate the use of lime and fertilizer in soil-maintaining rotations.

In common with most other improved practices, greater use of lime and fertilizer, especially on cash crops, would increase the volume of farm products that goes to market, which in turn would tend to reduce the prices of the products that would be produced in greater volume. But the farmers who use the fertilizer would have lower costs per unit of product and a larger quantity for sale as an offset to lower prices. And it is to be remembered that, so far as the increased use of these materials promotes soil-building rotations, the emphasis is shifted away from the staple cash crops that are likely to be overproduced. Such shifts therefore might actually aid in avoiding market gluts of some products. Moreover, part of the increase in lime and fertilizer constitutes a capital investment in permanent soil improvement that is in the interest of future welfare, both for individual citizens and for the Nation as a whole.

Changes in Crops

The greatest contribution of crop and variety changes to increased war production was the interwar development of improved seeds that greatly increased the yields per acre of our most important crops. Hybrid seed corn is an outstanding example.

In the war years the most significant expansion of the strictly war crops was in hemp for hard fiber. Its harvested acreage was increased from 1,248 acres in 1935-39, grown mainly in Wisconsin and Kentucky, to 146,200 acres in 1943 when hemp was grown in several Midwestern States. A Government corporation was organized to contract for acreage in suitable areas, and to construct and operate hemp-processing plants in the new producing localities. Different kinds of vegetable seeds, mung beans, castor beans, and some pharmaceutical plants were grown to alleviate or to protect against war shortages. These were important war crops. But they were concentrated in small areas, they occupied only small acreages, and they constituted a rather insignificant part of the total volume of agricultural production.

On the other hand, large contributions to wartime production were made by increasing some crops that were of minor importance in the interwar years. Soybeans were the most important among this group. They are one of the oldest of the cultivated crops but their production in this country has occurred mainly in the twentieth century, and commercial production of soybeans has been developed mostly since 1920. The acreage grown for all purposes increased from about 50,000 in 1907 to 460,000

acres in 1917. But in the latter year the output of most of the acreage harvested for beans was used for seed. The acreage harvested for beans to be used both for seed and for crushing expanded from 448,000 in 1924 to 10.2 million in 1944. The acreage harvested for beans in 1944 was 237 percent of that acreage in 1939. About half of this increase represented a shift from harvesting soybeans for hay to harvesting for beans. Most of the increase in soybean acreage took place in the Corn Belt, although large percentage increases occurred also in the Mississippi Delta and in the Atlantic Seaboard States of North Carolina, Virginia, Maryland, and Delaware. A somewhat reduced acreage in 1946 was followed by a record acreage in 1947.

In the Corn Belt the crops replaced by soybeans were mostly small grains, hay, and rotation pasture. During the interwar years some of the land previously devoted to corn had been shifted to soybeans, but during World War II corn and soybeans increased concurrently. On the whole, soybeans have replaced crops that have lower volumes of output per acre so the shift has added to the total volume of production.

Figure 16 shows the growth in acreage of soybeans harvested for beans from 1924 to 1947. It brings out the preeminence of the Corn Belt in the soybean enterprise. But the acreage trends are only part of the story. The trend in yield per acre has been upward, and by far the highest yields have been obtained in the Corn Belt. Thus in the years 1940-44 the five Corn Belt States had 83 percent of the acreage harvested for beans and 88 percent of the total production.

New varieties of soybeans, especially the Lincoln, give promise of further increases in yield per acre within the next few years. The levels of wartime acreage are not likely to be maintained when other sources of oil become more readily available, but it seems probable that both acreage and production will remain at much higher levels than they reached before the war. Soybeans in the Corn Belt have a nearby market for meal, which usually equals or exceeds the value of the oil, so the oil may become the byproduct from soybeans grown chiefly to supply high-protein concentrates. On this basis they can compete more readily with other sources of edible oil.

Peanuts are not a new crop, even in this country, but they were given special emphasis during the war, and they made a significant contribution to the wartime food supply. Only relatively small proportions of the peanuts have been crushed for oil, however; most were used for nuts or other direct food products such as peanut butter.

Figure 17 shows the acreage of peanuts grown for all purposes, the acreage picked and threshed, the yield per acre and production for the years 1909-47. The acreage of peanuts picked and threshed nearly doubled

from the prewar years 1935-39 to 1944. As the acreage expanded, into new areas and on farms of new growers in old areas, the average yield per acre decreased. In many areas new producers obtained relatively low yields until they had become familiar with the crop.

Figure 18 shows changes in acreage, yield, and production by major producing areas. In the Oklahoma-Texas area the acreage was 3.8 times the prewar levels in 1943 but in 1944 it dropped back to 3.1 times the acreage in 1935-39.

The market for edible peanuts may remain relatively high in the postwar years. But as an oil crop, peanuts are likely to face keen competition that can be met only by prices that are in line with comparable oils. Perhaps more mechanized production practices can help to give competitive strength to peanut production. A much larger proportion of the total peanut acreage is likely to be hogged off as time goes by.

Flaxseed was the third oil crop that was greatly expanded during the war. The 6.2 million acres planted in the peak year 1943 was more than three times the average of 1935-39, but the acreage planted in 1944 dropped back to less than half that of the previous year, and in 1945 special acreage payments increased the planted area to 4.0 million acres. In 1947 a support price of $6.00 per bushel resulted in a planted area of 4.2 million acres.

Most of the flax is grown in spring-wheat States where it was formerly grown as a new-land crop in Minnesota, North Dakota, South Dakota, and Montana. Weed-free land is needed for successful production. Flax is considered a hazardous crop compared with its alternatives. In the drought year 1936 more than 80 percent of the planted acreage was abandoned in the Dakota-Montana area. As compared with the opportunity to grow an unlimited acreage of wheat at loan-rate prices, farmers in the spring-wheat States would have hesitated to take a chance on flax without the special financial inducements that were offered.

Flax yields per harvested acre were higher during the war than in 1935-39. In 1943 and 1944 they were more than 50 percent higher in the Dakota-Montana area. Flaxseed production, on the larger acreage and with the higher yields, in the years 1940 to 1945 ranged from two to nearly five times the 1935-39 level. In 1943 the Dakota-Montana area produced more than 8 times as much flax as in 1935-39.

It does not seem likely that flax acreage will be maintained at 1947 levels without special price or production incentives. On the other hand, it might be stabilized at levels above the 1935-39 acreage, which was extremely low because of the drought. The acreage planted to flax in the Dakota-Montana area will depend largely on the profitableness of wheat production.

Dry edible beans and dry peas are sources of vegetable proteins that can be substituted, to some extent, for the animal proteins. As they also can be readily stored and transported, these direct food crops are well suited for war and relief needs.

The dry-bean acreage increased from the 1.9 million acres planted in 1935-39 to 2.6 million in 1943, which was the peak year. In 1944, the planted acreage dropped to 2.2 million acres, and in 1947 it was below the prewar average of 1.9 million acres. Yields were disappointing in many of the new producing areas; and the competition of other cash crops was too keen to allow the bean acreage to remain at the high level reached in 1943.

In contrast to beans most of the dry peas are grown as a supplement to other crops rather than in competition with them. Where the annual precipitation is 18 inches or more peas can replace summer fallow on the wheat lands of the Pacific Northwest. The yields of wheat are somewhat lower in a wheat-pea than in a wheat-fallow sequence, but the returns from wheat and peas are usually much higher than from wheat and fallow. This was especially true during the war, when prices were supported at $5.65 per hundredweight for No. 1 peas at country shipping points.

Peas are also a highly mechanized crop, and they use about the same machines as wheat. They therefore supplement wheat production with respect to both land and machinery. And, as labor requirements per unit of product are low, the output per unit of additional land, equipment, and labor resources is high. This is true only in certain areas, however, and there only to the extent that peas can be grown as part of the wheat-pea sequence. Expansion beyond that point means that peas have to be substituted for wheat and grown in succession, or that they replace other crops in other producing areas.

At the beginning of World War II considerable acreage was available for expansion of peas on the basis of supplementary use of resources. Figure 20 shows how rapidly the acreage of peas expanded during the war. The peak was reached in 1943 with 825,000 acres. This was a much larger acreage than could be grown as a supplementary crop, so some land grew peas in successive years, not only at the expense of wheat but also at a sacrifice of soil maintenance. Peas also were grown in some areas that were not well suited to them. The 752,000 acres planted in 1944 represented a closer adjustment of pea acreage to desirable wartime use of resources. In 1947 the planted area was 551,000 acres.

When the food emergency subsides there is no foreseeable domestic food demand for the quantity of peas that were grown in recent years. They could be grown for a high-protein livestock feed, but the price would be much below wartime levels if they were to compete with other

protein feeds. It seems likely that acreage will decline considerably, but it might stabilize at somewhat higher levels than the prewar average.

A crop change that developed gradually over the interwar and war years was the shift in the hay acreage from grasses to the higher yielding legume hays, which have a higher protein content and therefore help to balance the livestock ration. Figure 21 shows the digestible protein available in hay per roughage-consuming animal unit, by 5-year periods from 1920 to 1944 and for the three-year period 1945-47. This chart summarizes the changes that have taken place. It indicates that except for the drought years (included in the period 1930-34) the increase has been gradual throughout the entire period. The shift toward higher quality and higher yielding legume hays is likely to be accelerated in the postwar years as farmers begin to include more hay and pasture in their crop rotations. The higher protein content of the hay crop will help to balance the ration, and the increased yield of hay will offset at least part of the reduction in volume of production that otherwise would accompany a smaller acreage of intertilled crops.

Development of hybrid seed corn is easily the most important of the interwar and wartime crop improvements. Because corn normally occupies from 25 to 30 percent of the harvested cropland any improvement that greatly increases corn yields will naturally have a substantial influence on total production.

Commercial hybrid seed corn was first produced in Connecticut about 1922. Hybrids adapted to the Corn Belt became available in 1929. In 1933 a total of about 143,000 acres was planted with hybrid seed, and in 1947 about 61,690,000 acres. Figure 22 shows the percentage of the corn acreage planted to hybrids, by years since 1933, in the North Central States and in the United States. Adoption of hybrid seed has been especially rapid in the North Central States where adapted hybrids were available to farmers earlier, and where corn is the leading farm crop.

Experience with hybrid seed indicates that acre yields are increased about 20 percent over the yields of open-pollinated varieties. The percentage increase is usually about the same on good as on poor land, which tends to give additional advantage to higher yielding areas because expenses do not rise in proportion to the increase in yields.

Corn production in 1944 was nearly 35 percent above the average in 1935-39. The acreage harvested was 1 percent greater, and yields per acre were 31 percent higher. A part of this increase in yields can be attributed to better growing weather than in 1935-39, and a smaller part of it to use of more fertilizer and improvement in cultural practices. But the most effective influence was the greater use of hybrid seed.

Assuming an average increase in yields of 20 percent over open-pollinated corn, hybrid seed added 400 million bushels to the 1944 corn crop. Nearly 16 million more acres would have been required to grow that much corn if open-pollinated seed had been used.

As already indicated, the corn crop of 1946 was an all-time record of 3.2 billion bushels. But the 1947 crop of 2.4 billion bushels was the smallest since 1936. Power machinery and hybrid seed did wonders in overcoming the handicaps of an unfavorable planting season, but the dry hot weather which continued through the month of August in the Mississippi Valley was largely responsible for the greatly reduced corn yields.

The experience with the 1947 corn crop emphasizes that although hybrid seed and power machinery can help to alleviate unfavorable weather conditions, they are far from adequate protection against weather hazards. In years of average weather, however, it appears that 3-billion-bushel corn crops will become the rule rather than the exception in postwar years--even with some contraction of acreage to make room for more hay and pasture. A farmer must bear in mind, of course, that higher yields of corn remove more fertility from the soil, and that this necessitates using more commercial fertilizer, better crop rotations, more livestock, and better utilization of farm manures, if yields are to be maintained.

Annual production of sorghums for grain in the years 1942-44 was 242 percent of the prewar years 1935-39. The grain sorghums are grown largely in the Great Plains States where the yields vary over a wide range, depending upon weather. Figure 24 indicates that both acreage and production have increased within recent years. Relatively favorable weather, development of new high-yielding varieties that can be harvested with a combine, and the high wartime prices for feed grains, have all contributed to the increased production of grain sorghums. A larger acreage of winter wheat and low abandonment held down the acreage of grain sorghums in 1945. Less favorable growing weather reduced the yield to 15.1 bushels compared with an average of 17.3 bushels in the years 1940 to 1944. In 1947 production was 95.6 million bushels from 5.6 million acres. The acreage was low because of the large wheat acreage, but the yield per acre was close to the 1940-44 average.

New varieties of oats have now been introduced that result in increases comparable to those of hybrid corn in yields per acre. But the effect on the total production of oats has not been so noticeable because the improved varieties have not yet been used over as extensive areas. However, better winter varieties adapted for the South have helped to expand acreage and to obtain higher yields in that region. New varieties--such as Tama, Boone, Vicland, and Marion--adapted to the Northern States, have been grown on a wider scale recently, and now the

Clinton variety is proving superior to these in some areas. With wider adoption of improved varieties, oats may have a stimulation to yield similar to that which was given to corn in the late 1930's and early 1940's.

Wheat production averaged more than one-fourth higher in 1942-44 than in 1935-39, with a planted acreage only four-fifths as large (fig. 25). More favorable growing weather than in those earlier years is of course the outstanding reason. Figure 26 indicates that a considerable part of the increase in yields during the war was recovery from the drought levels of the 1930's. This is especially evident in the hard-winter and spring-wheat States, which had more than 70 percent of the planted acreage in 1940-44. The successive record wheat crops of 1946 and 1947 are largely attributable to exceptionally favorable growing conditions which resulted in high yields on the extensive seeded acreages.

But in addition to the favorable weather of recent years there appears to have been an upward trend in yields in the last decade or so that was badly obscured by the drought cycle. It seems reasonable to expect yields higher, by about 2 bushels per planted acre, in the next few years, than the long-time prewar average. Back of this increase are improved varieties, soil and moisture-conserving practices, and mechanization which increases the timeliness of operations.

Although both the acreage and the total production of cotton have been lower in the war and early postwar years than in 1935-39, the yield per acre has continued the increase that seems to have begun in 1931. The yield receded somewhat in the drought years, but it reached a new peak in 1937, and an all-time record in 1944. Weather conditions were exceptionally unfavorable in 1946 which accounts for the relatively low yield that year. In 1947 the yield per acre was 265 pounds of lint. Figure 27 shows the contrasting trends of cotton acreage and yield per acre.

The continued increase in yields of cotton can be attributed mainly to the following factors: (1) Use of more fertilizer, (2) a shift to higher yielding areas with reduction in acreage, (3) careful selection of land within each area and on individual farms, (4) use of improved varieties, and (5) increased use of legumes. These factors have not operated with equal effectiveness in all cotton-producing areas. The result has been a considerable shift in production between areas. This is brought out in figure 28, which indicates that the Irrigated, the Delta, and the High Plains areas have increased their production of cotton above their 1928-32 levels. In some other areas, as in the Texas Blacklands, production in 1944 was below 50 percent of 1928-32.

Other crop changes that have influenced the level of production materially are the increased yields per acre of white potatoes, the increase in both acreage and yields of fresh and processing vegetables, and the larger acreage and greater bearing surface of fruit trees.

Changes in yield per acre harvested of white potatoes in selected States and for the United States from 1919 to 1947, are shown in figure 29. The upward trend in yields is pronounced in nearly all the chief commercial States. The United States average shows a gradual upward climb; it was interrupted for several years in the early 1930's but reached new highs in the early 1940's. The 1946 yield of 186.3 bushels per acre harvested was the highest on record.

There are two principal reasons for the higher yields of potatoes. Adoption of a whole group of improved practices is one--raising higher yielding varieties, use of more fertilizer, and more effective insect and disease control. The second reason is that these improvements, combined with mechanization, have pushed more of the production into the hands of specialized commercial growers who use the new methods on large acreages, in areas that are especially adapted to potatoes. This has brought a considerable change in the location of the production both within several of the chief producing States and among the different States. The harvested acreage of potatoes has gone generally upward since 1919, in California, Idaho, and Maine. On the other hand the acreage in the Lake States (Minnesota, Wisconsin, and Michigan) has had a downward trend. The most rapid increase in recent years has been in Kern County, California where very high yields are obtained under irrigation.

Gradual concentration of potato production, largely in the hands of specialized producers who are located in the most favorable areas, is still under way, and is likely to continue for several years. If weather conditions are favorable, new yield records may be established as the large-scale, specialized producers make further improvements in their methods.

Acreages devoted to commercial truck crops increased sharply between the two wars (table 6). Improvement in techniques of production, better knowledge of disease and insect control, and better methods of marketing and distribution gave producers added incentives on the production side. Greater appreciation by consumers of the nutritional value of vegetables in the diet contributed to an expanding consumer demand and provided a market for a corresponding increase in production.

Table 6.- Harvested acreage of commercial truck crops for fresh market and for processing, United States, 5-year averages, 1920-44, and annual 1940-45

Year	For fresh market	For processing	Total
	Thousand acres	Thousand acres	Thousand acres
1920-24	739	741	1,480
1925-29	1,160	1,025	2,185
1930-34	1,600	1,064	2,664
1935-39	1,744	1,386	3,130
1940-44	1,699	1,799	3,498
1940	1,711	1,394	3,105
1941	1,682	1,664	3,346
1942	1,649	1,997	3,646
1943	1,573	1,958	3,531
1944	1,879	1,984	3,863
1945	1,893	1,943	3,836
1946	2,047	2,062	4,109
1947 1/	1,844	1,850	3,694

Acreages of fresh-market vegetables increased more rapidly than the acreages of vegetables for processing, between the wars. Production of processed vegetables increased rapidly after 1933, however, partly because of improvements in the freezing of foods and the resulting rapid expansion in demand for frozen vegetables.

Consumption of fresh vegetables, per capita, increased from an average of 205 pounds in the period 1920-24 to 235 pounds in the 5-year period 1935-39, to 237 pounds in 1943, and to 250 pounds in 1947. Consumption of canned vegetables was 19.6 pounds net canned weight per capita, in 1920-24, 31.1 pounds in 1935-39, 34.5 pounds in 1943, and 42.4 pounds in 1947.

1/ Preliminary estimate.

The upward trend in acreage of fresh-market vegetables in the inter-war period was reversed, beginning about 1940. From 1940 to 1943 there was a definite downward movement. This was influenced in part by the growers' difficulties in obtaining farm labor and production supplies, by more emphasis on other needed commodities, by a shift from fresh to processing vegetables by many growers, and by the victory gardens that displaced some of the commercial market.

The relatively small acreage in 1943 resulted in very high prices to growers, and consequently in high returns per acre. Expansion of acreage the following year was thus stimulated; and 1944 had the highest acreage of fresh-market vegetables that had ever been harvested. Even that acreage was exceeded in 1945 and 1946 but a somewhat smaller acreage was harvested in 1947.

In contrast to the downward trend of fresh-market vegetables during the first 3 war years, the acreage of vegetables for processing increased sharply in 1941, and again in 1942. It was maintained at or about the 1942 level from 1943 to 1947. This means an average about 40 percent above the 1935-39 average. Heavy wartime demands for processed foods for military and lend-lease use provided the basis for this expansion. The major processing vegetables were supported at prices favorable to the growers and this encouraged grower interest in meeting the requests for greater production.

The demand for canned vegetables may drop considerably after the requirements for relief work have subsided. But there is every reason to anticipate an expanding outlet for frozen vegetables which may more than compensate for any decline in the quantity of processing vegetables that go into cans. The peacetime outlook for all vegetables will be closely related to the level of consumer purchasing power, but a further rise in per capita consumption can be expected.

With the exception of citrus fruits the wartime changes in fruits came primarily in the utilization of the crop rather than in the volume of production. Bearing acreage of tree fruits is not susceptible to much change within a few years, so higher demand is reflected mainly in higher prices rather than in increased output. Most commercial acreage must be well cared for at all times, and orchards that are allowed to deteriorate through lack of care usually cannot be restored. More fertilizer and better cultural practices will bring increased yields in many orchards, but the scarcity of labor and supplies during the war largely prevented using these means to increase the output. Changes that occurred during

the war therefore were usually continuations of trends that were in evidence during interwar years. Strawberries and cranberries are the only important fruit crops in which acreage and production were materially affected by the war. Acreage of these two crops combined declined from 205,000 in 1941 to 107,000 in 1945. Decline in production was even more marked.

Acreage of deciduous fruit trees of bearing age reached its highest level in the late 1920's and early 1930's. During the last decade the acreages of most of the deciduous fruit trees have declined gradually but citrus trees have increased. Total production of combined fruits has increased; this is attributed almost entirely to the rapidly expanding production of citrus fruits. Fruits other than citrus have remained at a relatively constant production level during the past 15 years (fig. 30).

The striking point in the fruit picture is therefore the change that occurred in citrus production. From a relatively unimportant part, citrus fruits have increased until they constitute almost one-half of total fruit production on a tonnage basis. Citrus production rose from about 2 million tons in 1929 to 7.1 million tons in 1943--a three-fold increase in 15 years. The trend is still sharply upward. As most of orange and grapefruit trees have not yet reached full production, with present numbers of trees and with normal care of orchards, production and yields can be expected to keep on rising through several decades for the trees are relatively young and they have a long productive life.

Yields of all fruits on a bearing-acreage basis have increased within 15 years. The higher average age of the trees probably has been the most influential single cause. This holds true even for apples, although little further increase in yields of apples can be expected because of older trees.

A shift to fruit production usually means that a product of higher value per acre is obtained as soon as the orchard is of bearing age and the output increases as the orchard grows toward maturity. These factors partly account for the large increases in farm production over a period of years in Florida and in the Pacific States.

Because many fruits are still considered to be virtually a luxury food by many consumers, the level of national income will be even more important to growers of fruits than to producers of other agricultural commodities. If costs of both production and marketing can be reduced, and if such improvements are reflected in prices that induce larger consumption, the markets for fruit can be gradually expanded.

Changes in Livestock Production

Three major forces are back of the recent changes in livestock production. They are: (1) the shift from animal to mechanical power, (2) the variations in the total feed supply, and (3) the higher production per animal.

The decrease in horses and mules of 15 million animal units from 1920 to 1946 released land that could grow feed for an equivalent number of productive livestock (animals and their products that are produced for human use). The saving in grain alone amounted to about 16 million tons in 1946--enough to feed 32 million hogs to market weight.

Year-to-year changes in the total feed supply have been about as influential in their effects on livestock production for human use as the shift to mechanical power. The severe drought years, 1934 and 1936, reduced total feed consumption (feed grains, hay, and pasture) about one-fifth below the 1928-32 average. On the other hand, total feed consumption in the war years 1942-44 averaged about 28 percent above the 1928-32 levels, and 34 percent higher than those for 1935-39. Feed production in the years 1942-44 increased more than in proportion to the increase in numbers of livestock. Total numbers of livestock fed increased 20 percent above 1935-39. However, the increase in livestock production was greater than this. Excluding horses and mules the increase in production was over one-third. Livestock production was reduced in 1946 and again in 1947. The short corn crop of 1947 places definite limits on expansion in 1948.

In addition to the changes in the supply of feed there have been notable changes in quality, resulting in the feeding of rations that are more balanced with respect to protein and other nutritive elements. The gradual increase in the protein content of the hay supply has been mentioned (fig. 21). The greater supply per animal unit of oilseed meals and other high-protein feeds during the war also helped to balance the feeding rations and to push livestock production upward.

Changes that have taken place since 1919 in production per unit of breeding livestock are shown for all cattle, and for hogs and poultry in figure 31. Figure 5 showed changes in the total production of livestock for human use per animal unit of breeding livestock. These series of production per animal unit of breeding livestock are similar to series that show changes in yields per acre of different crops and production per acre of all crops. They measure the combined effects of all the forces that are back of the changes in livestock production per unit of breeding stock. Similarly, the indexes of crop yields per acre, or an index of production of all crops per acre, measure the combined effects of all the forces that operate to change crop yields, or the total crop production per acre.

Changes in livestock production per animal unit of breeding livestock are influenced by weather, chiefly because feed supplies are affected by favorable or unfavorable growing conditions. The bad drought years of the 1930's are reflected in reduced production per unit of breeding animals for all three classes of livestock. But the downward trends shown for those years in figure 31 probably also reflect less attention to livestock in other ways because of the depression and the low prices. On the other hand, the years that combine large feed supplies and favorable prices for livestock soon show the increased production that results both from more liberal feeding and from better care in other ways. For example, in cattle production a larger calf crop, reduction in death loss, and prevention of disease all combine with better feeding and other care to produce more meat and milk per cow in the breeding herd.

One measure of increased efficiency in livestock production is the increase in output per unit of feed. There is evidence that significant gains have been made in this direction in all classes of livestock but the data available on a national basis are not sufficiently refined to allow these changes to be traced. Information obtained in the Corn Belt over a period of years on feed consumed by hogs indicates a reduction of 10 to 15 percent in the quantity of feed used per 100 pounds of pork from the decade of the 1920's to the decade of the 1930's. 5/ The number of pigs saved, the prevention of disease, the improvement of breeds, and the feeding of balanced rations all tend toward increased efficiency in the use of feed.

If similar data were available for tracing changes in feed consumed per 100 eggs produced it seems probable that even greater reductions in feed per unit of product would be shown. Even the over-all national estimates indicate a reduction of about 12 percent in concentrates consumed per 100 eggs produced from the period 1920-24 to 1937-41. 6/

The sharp rise in poultry production per unit of breeding stock reflects in part the large shift to broiler production that has developed. However, figure 32 shows the trend of egg production per layer for the average number of layers on farms, and this series on egg production also shows a sharp upward climb, especially within recent years.

5/ "Feed Consumption and Marketing Weight of Hogs," by L. Jay Atkinson and John W. Klein. U. S. Dept. of Agr. Tech. Bul. 894, 1945, pp. 19-21.

6/ "Feed Consumption by Livestock, 1910-41," by R. D. Jennings. U. S. Dept. of Agr. Cir. 670, 1943, p. 28.

The trends in poultry and egg production reflect the noteworthy improvements that have been made in the poultry enterprise. In many parts of the country, and especially in the Midwest, it has been transformed from a sideline to an important phase of the farm business.

Figure 33 shows the changes in milk production per cow over more than three decades. There was a sharp increase in the 1920's, and then a drop from 1929 to 1934, reflecting the drought and depression conditions then prevailing. Larger numbers of cows were milked during the depression than in the 1920's. As a result, a larger proportion of the cows milked were of beef or mixed breeding. And the feed supply was reduced by drastic drought. Milk production per cow did not return to 1929 levels until 1938. It was maintained at high levels during the war and reached a record level of 4,891 pounds per cow in 1946. Preliminary figures indicate that this was exceeded in 1947.

That production per cow seems high in relation to previous years but there is still room for considerable improvement. The average milk production per cow, for cows on which full-year records were kept by Dairy Herd Improvement Associations in 1944, was 8,296 pounds compared with a national average of 4,578 pounds in that year. In other words, the cows in Dairy Herd Improvement Associations produced about 81 percent more milk per cow than the national average. These two estimates of production per cow are not strictly comparable, but the wide difference between the two figures does indicate the potentialities of greater production per animal.

More feed per cow, and better balanced rations, would be the two most influential factors in achieving a higher national average production per cow. Because such a large proportion of the feed used by a dairy cow is required for maintenance, underfeeding means that most of the feed is used for body maintenance, and a relatively small part of it for milk production. In the newer dairy areas, and where dairy production is only a sideline, underfeeding is rather common.

It is recognized, of course, that there are economic limits to increased feeding and that these are reached before the physical limits are approached. The economic limits will vary with the price of the product in relation to the cost of feed, and in relation to other expenses. This is true in all classes of livestock. But many farmers feed their cows at levels far below the economic limits, even when milk is high in price in relation to feed. On the majority of farms to increase the feed supply per animal, for dairy cows as well as for other classes of livestock, would increase both output per head and net income to farmers.

Other factors also will tend to increase production per animal in the years ahead. In dairy cattle, artificial insemination makes it possible to develop the higher milk-producing strains more rapidly than previously. On many farms the herd bull will disappear, and the feed that was formerly consumed by the bull will be fed to milk cows. More progress will be made in control of disease for all classes of livestock. Improvements in hog breeding are already under way that will increase efficiency in use of feed and produce a higher quality carcass.

More progress is called for in improving shelter and equipment, in order to reduce labor and capital requirements in caring for livestock. Further improvementss in the quantity and quality of the feed supply and in reducing the cost of making the feed available to livestock are badly needed. As farmers shift toward more soil-conserving systems of farming, more hay and pasture will be available, and that means more roughage-consuming livestock. But improved techniques are needed to produce the roughage in ways that will result in more livestock and livestock products at lower cost per unit of product.

As the introduction of mechanical power gradually makes further progress in the South, the numbers of productive livestock are likely to increase, because of the feed that will be released and because systems of farming are likely to be developed that include more hay, grain, and pasture--crops that can be handled by mechanical equipment. Cattle numbers have increased relatively more in the humid areas of the country than on the ranges, of late, because of the shift to tractor power. This proportionately greater increase is likely to continue. On the ranges, expansion of livestock production is dependent upon improvements that will increase carrying capacity, and upon developments that will make it possible to produce more winter feed.

Changes in Farm Sizes and Ownership

Factors responsible for a large part of the production increases also have had considerable influence on changes in the number and sizes of farms (table 7 and fig. 34). A part of the change in sizes of farms since 1920 results from factors related to development of new arable land in the West, abandonment of land in the East, and the very considerable growth in part-time farming. But technological forces have influenced those changes. And they have also directly affected both the changes in number of farms and their size distribution.

The total number of farms counted in the census of agriculture decreased 9 percent from 1920 to 1945. On the other hand, the "land in farms" increased 19 percent. The latter change occurred largely in the 17 Western States. In fact, the land in farms decreased in most of the Eastern States during this period.

Table 7.- Number of farms by size groups in the United States, census years 1920, 1930, 1940 and 1945

Census year	Total	Acreage size group						
		Under 10	10-19	20-99	100-259	260-499	500-999	1,000 and over
	Thousands							
1920	6,448	289	508	2,978	1,980	476	150	67
1930	6,289	359	560	2,815	1,863	451	160	81
1940	6,097	506	559	2,512	1,796	459	164	101
1945	5,859	594	526	2,286	1,693	473	174	113

In the quarter-century from 1920 to 1945 there was a 106 percent increase in the number of extremely small units that are counted as farms by the census, those under 10 acres, (table 7 and fig. 34). Farms of that size are mostly part-time farms, rural homes, and retirement units. Very few of them are considered as actual farms in the areas where they are found. But they are counted by the census as farms because they are 3 acres or more in size, or have value of products of $250 or more. The number of farms from 10 to 19 acres increased slightly from 1920 to 1945; these are also frequently part-time farms.

In contrast to the large increase in numbers of the extremely small farms, there was a 23 percent decrease in what might actually be called "small farms," those from 20 to 99 acres in size. There were 692,000 fewer farms in this group in 1945 than in 1920. There were also 14 percent fewer farms in the size group 100 to 259 acres. This group includes our traditional "160-acre homestead" size. But the group from 260 to 499 acres nearly held its own; it showed only a 1-percent decrease in number of farms from 1920 to 1945.

At the upper end of the size-of-farm scale there was an increase in the number of farms during this period. The group from 500 to 999 acres showed an increase of 16 percent, and those of 1,000 acres and over increased 69 percent. Although the group of farms of 1,000 acres and over was two-thirds larger than in 1920, that group still contained less than 2 percent of the total number of farms in 1945. But operators of farms

of that size controlled about 40 percent of the total land in farms. This seems like a rapid trend toward concentration of land holdings until we analyze the data more closely. About 87 percent of the number of farms of 1,000 acres or over were found in the 17 Western States. This means that the increase took place mostly in the ranching and dry-land wheat areas where 1,000 acres is not a large-scale farm. But there has actually been some increase in farms of 1,000 acres or over outside of the grain and ranching areas of the Western States.

We have had some growth in large-scale farming. More important, however, was the shift to larger farms within the size groups included between 100-999 acres. That change can be characterized as a trend toward larger, more commercial family farms rather than toward large-scale farming. It was made possible and has been accelerated by technological changes, especially by adoption of mechanical power and complementary equipment.

Farmers in the size groups from 100 to 999 acres controlled nearly half of the land in farms in 1945. They constituted 40 percent of the total number of farms counted by the census in that year. About 48 percent of the total number were in the small-farm size groups (10-99 acres), but farmers in that group controlled only about 11 percent of the land in farms. The extremely small farms, those under 10 acres, had less than 1 percent of the land in farms. And even though this group more than doubled they constituted only about 10 percent of the total number of farms counted by the census in 1945.

In summary, the census changes in sizes of farms from 1920 to 1945 show a doubling of the extremely small or "nominal" farms, an increase of two-thirds in farms of 1,000 acres and over, some increase in the number of farms of 500-999 acres, and much more than offsetting decreases in the small and middle-scale groups. These changes resulted in a 9-percent decrease in the total number of farms; also a 32 percent increase in the average acreage of all farms, which was 148 acres in 1920 and 195 acres in 1945.

Looking forward, some of the same forces are likely to continue to influence changes in the number and sizes of farms as have operated over the last quarter-century. We might expect a further large increase in the number of part-time farms and rural homes. The full-time family-operated farms are likely to be fewer and larger. And there might be some further increase in the number of large-scale farms, but they will still constitute a relatively small percentage of the total number of farms.

There have been noteworthy changes in farm tenure during the last quarter-century. Census returns for 1945 indicate that about 32 percent of all the farms counted by the census were operated by tenants, as contrasted with 38 percent in 1920. Tenancy increased in the decade following 1920, and 42 percent of the farms were operated by tenants in 1930. But by 1940, the percentage of tenancy was about back to 1920 levels. A considerable decrease between 1940 and 1945 resulted in the lowest level of tenancy since before 1900.

The number of full owners actually increased 7 percent from 1940 to 1945, at a time when the total number of farm operators decreased 4 percent. A large part of the increase in farm ownership is accounted for by the greater number of farms under 10 acres in size, about 75 percent of which are owner-operated.

The number of part-owner farms increased about 18 percent from 1920 to 1945, and the acres of land they operated by 112 percent. The greater number of part-owner farms helps to explain how so many farms have increased in acreage. Farmers who owned some land have rented adjoining farms or separate tracts that could be combined with their own land for operation as a more efficient unit.

Owner-operatorship of family farms is considered one of the goals of agricultural policy. And the tenure figures for 1945 indicate considerable recent progress toward that goal. Recent data on mortgage debt also indicate that farmers have greatly increased their equity in the land they own. Only 29 percent of the Nation's farms had mortgages in 1945, compared with 39 percent in 1940. The total farm-mortgage debt shrank from 6.6 billion dollars in 1940 to a low of 4.7 billion dollars in 1946. But the downward trend was reversed from 1946 to 1947. Although the total debt increased only 2 percent (to 4.8 billion dollars) there were large increases in several States of the East, South, and West that were partly offset by continued reductions in the Midwest. Preliminary data indicate a further rise in mortgage debt during 1947. The blind spot in the mortgage situation is the distribution of mortgage debt among individual farmers. If a large part of it is on farms where young men have made commitments at high prices financial trouble spots are likely to develop with any downturn in net farm incomes.

Incentives for Increased Production

That farm production in the 1930's was held in check by drought and depression, despite the technical progress in mechanization and in other lines, has been emphasized. War needs and the incentive of higher incomes broke this dam and released a flood of increased production. But this was not accomplished by one blast at the beginning of the war. It was a fairly

Table 8.- Number of farms by tenure of operator in the United States, census years 1920, 1930, 1940 and 1945

Census year	All Operators	Tenure of operator*			
		Full owners	Part owners	Croppers	Tenants other than croppers
		Thous.	Thous.	Thous.	Thous.
1920	6,448	3,366	559	561	1,894
1930	6,289	2,912	657	776	1,888
1940	6,097	3,084	615	541	1,820
1945	5,859	3,301	661	447	1,412

*Excludes managers.

gradual process. Both farmers and agricultural workers were too conditioned by the experience with surpluses to believe that the market really would absorb all that the agricultural plant might produce under stimulation. This skepticism was supported by the sag in prices of some products during the year that followed the outbreak of the war in Europe.

But gradually the war demands emerged, and with the passage of the Lend-Lease Act on March 11, 1941 they gathered a momentum that remained unslackened for the duration of the war.

The first public pronouncement of the need for increasing the production of food was made by the Secretary of Agriculture on December 26, 1940, when he urged the desirability of breeding more sows for spring farrow in 1941. On April 3, 1941, price supports were announced for dairy products, hogs, chickens, and eggs, that would be effective until June 30, 1943. This announcement assured farmers of a market for expanded production of these products. But production controls were maintained on wheat, cotton, tobacco, and corn for the years 1941 and 1942. They were removed from corn in January 1943, from wheat in February 1943, and from cotton in July 1943.

Part of the reason for maintaining production controls in the early war years was to obtain a shift in the direction of meat, eggs, milk, and oil crops--the products most urgently needed in the first part of the war. But a more effective means was needed for achieving the most desirable combination of farm products. The program of formulating and announcing production goals, combined with support prices and with production payments that were geared to the relative urgency of need for different products, was developed to serve this need.

The first production-goals program was worked out in the summer and fall of 1941. It outlined the food needs for 1942 and stated the production objective for each product. These goals were revised in January 1942, following the attack on Pearl Harbor. Goals were successively developed for each of the succeeding years.

Production goals were one step in the process of arriving at a balanced production program. Before goals were determined for any product the prospective needs were analyzed in relation to the resources and the facilities available for its production. Then each product was considered in relation to all the other farm products that were needed in a balanced production program. Studies of production capacity for individual products, and for all products combined into a production

program geared to prospective needs, were made in each State to provide a production guide for the goals program. The production-goals program as finally developed pointed the direction and indicated the distance that should be traveled to achieve a balanced production.

Support prices and production payments, when balanced in relation to the desired production of each product, furnished most of the driving force that was needed to achieve the objectives outlined in the goals program. But education and information concerning war needs also played an active part, and patriotism helped as the war progressed. Many farmers grew soybeans, peanuts, flax, dry beans, and other strategic war crops because they felt the need was urgent, even though they might have obtained somewhat larger returns by growing other products.

So far as possible, however, support prices and production payments were intended to make the most urgently needed products the most profitable to the producers. Efforts in this direction were somewhat limited by the minimum loan provisions for some crops, and by price ceilings on others; but in general a pattern of support prices and payments was eventually achieved that was reasonably well balanced in relation to the war needs for each product.

With production goals to point the direction and to indicate the distance to be traveled; with support prices, production payments, and educational persuasion; with patriotism and family participation in the war as the fighting continued, as incentives to attainment, a level and pattern of production was finally achieved that was fairly well proportioned to war needs. Some of the demands for food were not satisfied. They could have been met only by devoting more labor, equipment, and materials to agriculture at the expense of other sectors of the war program. But the most urgent needs were satisfied, and the pattern of production was shifted in the direction of products with the highest war priorities. It seems doubtful that the large changes in production which were shown in figure 2 could have been accomplished without a program that emphasized the need for those changes, and that supplied incentives for obtaining them. Greater shifts from livestock products to direct food crops could have been made if the food requirements that were developed had called for more sacrifice in quality in order to provide food for more people. And if the need had been so urgent as to have forced a larger allocation of resources to agriculture it would have been possible to obtain much greater increases in production.

So far as materials were concerned, farmers felt the greatest pinch in new farm machinery, especially for the production year 1943, when only 23 percent of the 1940 volume of steel used for farm machines was originally allocated for that purpose. This allocation was increased

later, but new machinery was unobtainable for most farmers in 1943. More farm machinery could have been substituted for labor, and the process of mechanization would have been more nearly complete at the end of the war. This in turn would have facilitated agriculture's adjustment to peacetime conditions.

Shortages of some other materials developed early in the war. Fencing, building materials, containers, and other items were scarce; but the minimum needs were met by careful distribution of available supplies. Fortunately, the supply of insecticides and of commercial fertilizer was fairly ample, although more would have been used if it had been available.

Scarcity of labor constituted the worst obstacle to production in some of the seasonal cash-crop areas. The Office of Labor and the State Extension Services assisted in bringing in outside labor, and in recruiting and training local labor from previously untapped sources. Farmers and their families worked long hours, and somehow the essential jobs were done.

The end of the war relieved some of the scarcities of labor and materials. Farm population increased both in 1946 and 1947, and farm employment averaged 92 percent of 1935-39 in 1946 and 93 percent in 1947 compared with 90 percent in 1945. As already indicated, a large quantity of new machinery has been manufactured but it has not been available in sufficient volume to supply all farmers with all the machines they would like to buy.

Production goals and support-price programs were in effect for both 1946 and 1947, but the price-ceiling structure lapsed temporarily in July 1946, and after a short period of reinstatement was removed on nearly all products in the fall of 1946. Since that time most farm products have sold at prices above support levels, although potatoes, eggs, and some other commodities have required Government support at different times.

Prices received by farmers were 204 percent of their 1935-39 average in June 1946. In October 1946, after most of the price ceilings were removed, they were 255 percent of prewar, but they dropped to 246 percent in December 1946. In December 1947 they had risen to 281 percent, and in January 1948 to 287 percent. But a sharp decline brought them back to 261 percent of 1935-39 in February 1948.

It is evident that price incentives were even better in the first two postwar years than during the war. On the expense side, however, farm costs have also risen, but not so rapidly as prices received. Prices paid for goods and services used in farm production (not including farm wages) were 150 percent of 1935-39 in June 1946. They had risen to 163 percent in December 1946, and to 199 percent in December 1947. For the entire year 1947 they averaged 183 percent of prewar. Farm-wage rates in the

prewar years 1935-39 were only about two-thirds of the level prevailing in the 1920's. But they rose very rapidly during the war, and in June 1946 they were 321 percent of 1935-39. They averaged 346 percent of prewar in 1947.

With cost rates lagging behind the rise in farm prices, and with a much larger volume of output of marketable products, net farm incomes have increased a great deal. Figure 35 summarizes the gross and net farm-income results to the Nation's farmers of their production job during the war and early postwar years. The realized net income of farm operators for the war years 1942-44 averaged 240 percent of the 1935-39 level. In 1946 it was 317 percent of the average for those years; and in 1947 it was 383 percent--nearly four times the net income of prewar years. The rise in net incomes from 1946 to 1947 is almost entirely attributable to changes in prices because the volume of production was actually lower in 1947 than in 1946.

The operator's net farm income experience on family-operated farms for different types and locations is shown in figure 36. This chart traces the extremely low net incomes that prevailed during the drought and depression of the early 1930's, the slow recovery during the latter part of that decade, and the rapid rise in the war and early postwar years. The greatly increased production per farm in recent years has meant relatively lower expenses per unit of product; and with more products to sell the net incomes rose faster than the prices received for those products. In other words, a higher output per farm and per worker means relatively lower costs per unit and higher net incomes even without any rise in farm prices. But in recent years both this factor and rising prices have tended to push net incomes upward. If farmers should encounter several consecutive years of lower prices with cost rates remaining at or near present levels, their margin between expenses and gross income would narrow; and net incomes would be reduced faster than the drop in farm prices unless effeciency could be increased to reduce costs per unit of product and thus to offset the lag in cost rates.

IMPLICATIONS OF RECENT CHANGES

The forces that shaped the course of agricultural production in the interwar and war years have been analyzed briefly in these pages. Their effects on production are evident in the record-breaking volume during the war. Most of these forces still have unexpended power. And they will continue to influence production in the years beyond the transition from war to peace. New forces will be injected. Some of them are already on the horizon. Others cannot be foreseen, but they should be expected. And farmers will need to adapt their operations to the rapidly changing conditions.

Prospective Changes

Assuming that a stable peace can be established, and then looking forward beyond the transition years to the time when farming will be adjusted to peacetime conditions, some changes seem fairly certain. They will result from the operation of the forces now under way, and of those that are on the horizon. The changes that seem most likely to occur are summarized as follows.

1. A continuation of the shift to mechanical power until it has largely supplanted animal power is to be expected. Introduction of smaller tractors that are more suitable for small farms and rolling land will accelerate this shift in the South, and in other areas with small farms.

2. Further adaptation of machines for use with mechanical power is certain. Each phase of agricultural production will become more mechanized, and more fully adapted to mechanical-power techniques. Eventually the same type of stability may be achieved with mechanical power as was attained with machinery adapted for animal power, previous to World War I. But this process will require some time for full development.

Haying equipment will be adapted to the special conditions of each producing area. Mechanical cotton pickers and strippers will be adopted, gradually at first, and then more rapidly as changes are made for more effective use in areas of rolling land and small farms. Some progress may be expected in mechanizing such traditionally hand-labor crops as sweet-potatoes, and even tobacco.

3. Use of lime and commercial fertilizer will increase above the high 1947 levels. How rapidly this increase will come depends partly on the kind of educational and conservation programs that are developed, and partly on the level of farm incomes. But many farmers have now learned the value of lime and fertilizer, and they are not likely to reduce their purchases except under conditions of severe depression.

4. Along with the use of more lime and fertilizers will come more rapid adoption of other conservation practices, such as using winter cover crops, grass and legume crops in the rotation, contour farming, strip cropping and other practices designed for erosion control.

5. Further progress will be made in varietal improvements. For example, Lincoln soybeans and Clinton oats are now being adopted. Suitable corn hybrids are being developed and will be adopted in the Southern States. The effects of improved varieties of grain sorghums will become more pronounced.

6. More efficient methods to control pests and diseases will be available for both plants and animals. The effectiveness of the new materials and improved techniques for applications will become more evident in the next few years.

7. Results from animal-breeding experiments will gradually increase the efficiency of livestock production. Work now under way is likely to produce hogs that are more efficient converters of feed into pork of the more desirable cuts. Dairy-herd improvement will be accelerated by more widespread use of artificial insemination.

8. Further improvements will be made in feeding methods. More adequate and better balanced rations will contribute to increased output per animal.

9. Some new land will be brought under cultivation by irrigation, drainage, and clearing, but the total acreage is not likely to be large. If public development work now under way is continued and all authorized work is carried out, about 4.5 million acres will be brought under irrigation in the next 10 years. Around 8 million acres might be improved by drainage or clearing during the same period. About half of these developments would take place on existing farms and the rest would involve bringing new areas into production.

10. Some land will be abandoned in the poorer land areas. If opportunities for employment are freely open in the cities, many small and unproductive farms will shift from full-time to part-time operation, and even to rural homes on which little or no farming is done. If depression conditions should prevail for any length of time this movement might be reversed, as many unemployed people are likely to try to make at least a part of their living from the land.

11. As good roads, electricity, and other conveniences become more readily available in rural areas more and more people engaged in nonfarm employment will seek to establish rural homes. Thus the number of part-time farms and rural homes will be augmented from two sources: (1) Farm people shifting from full-time to part-time farming, and (2) urban people seeking homes on the land.

12. Fewer workers will be needed in full-time farming as mechanization gains momentum in cotton production, and in other enterprises that now require much hand labor.

13. Family farms are likely to become larger and somewhat fewer as the productive capacity of farm workers is increased by the newer techniques. Some increase in the number of large-scale farms should be expected, but they are not likely to constitute more than a small percentage of the total number of farms.

14. Commercial farming will become a more complex business as technological advances continue. This means that adequate training and managerial ability of a high order will be needed for successful operation of family farms.

Changes will occur that are now unforeseen. For example, we have no way of foretelling the impact on agriculture of developments in regard to atomic energy. Over the next quarter-century innovations may be even more significant than those which are now on the horizon. But they are likely to be less important in the next few years because a period of testing of new developments is usually required, and later adoption by farmers is a gradual process.

Effect of Prospective Changes on Farm Output

Prospective changes that have been outlined are preponderantly those that will tend to push the output of farm products for human use higher and higher, instead of allowing them to recede toward the prewar levels. In their recent study of peacetime production adjustments, State Committees estimated that under favorable economic conditions after the war it would pay farmers to produce products for human use at a level about 43 percent above the prewar average. 7/ These estimates gave consideration to maintenance of soil resources and included the effects of the adoption of known improvements that would be profitable under conditions of prosperity.

But these committees recognized that effective educational and other programs would be needed to accelerate the adoption of improved practices. Otherwise the output for human use is likely to increase more slowly than this estimate indicates would be profitable, even under favorable conditions; unless some new accelerating force is introduced. In the absence of special accelerating forces it might require 10 to 15 years to reach a level of output 40 to 45 percent above 1935-39. If economic adversity should prevail, the rate of increase in output would be slowed down, but even under unfavorable price conditions, it seems unlikely that the total output for human use would be reduced substantially unless weather conditions were below average. Any reduction that would come from the use of

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7/ "Peacetime Adjustments in Farming--Possibilities Under Prosperity Conditions," U. S. Dept. of Agr. Misc. Pub. 595, 1945.

less fertilizer, or from other attempts to reduce variable costs, would probably be partly offset by the effects of the landward pressure of unemployed people.

Severe drought, or other unfavorable growing conditions, could reduce the level of output considerably. In a drought year, like 1934 or 1936, the output might drop about 20 percent. But it would increase again when growing conditions improved. Some of the improved practices, such as using hybrid seed corn and drought-resistant varieties of wheat and grain sorghum, summer fallowing and contour farming, provide considerable protection against unfavorable weather. But on the other hand, the yield-increasing effects of fertilizer and some other practices would not be realized in case of severe drought. Crop loss from unfavorable weather is one of the major hazards in present-day commercial farming.

Aside from this hazard, most of the changes that have already taken place, as well as those in prospect, seem to point irreversibly in the direction of increased production. For the period immediately ahead there seems to be urgent need for all the food that can be produced. Food will help to restore the peace of the world. But when the transition to peacetime market outlets has been completed, food production at high levels may have to face market difficulties, unless high employment and purchasing power are maintained, and the channels of international trade are kept open.

But regardless of the market outlook, there is no road back from the agricultural revolution that has been experienced in recent years. Attention therefore necessarily centers on mobilization for efficient and profitable peacetime agriculture instead of reconversion to a prewar situation that will never return.

If the belief still lingers that production will recede to prewar levels, under average weather conditions, the steps that would be retraced should be considered. Farmers generally cannot go back to animal power. There are too few horses and mules now on farms. The annual colt crops do not begin to maintain even present numbers. The mechanical-power phase of mechanization is here to stay, and it is the cornerstone of high-volume output for the market. Going back to open-pollinated corn, or to low-yielding strains of other crops would be decidedly unprofitable even under depression conditions. And more effective control of insect pests and diseases is likely to be continued somewhat regardless of price conditions.

It is possible that less fertilizer and lime would be used in a depression, of course, although it would be poor economy to reduce yields

in this way. And it would be contrary to the national interest to fail to apply the fertilizer that is necessary for maintaining stable, soil-saving crop rotations. Similarly, temporary reductions in expenses could be made by not carrying out certain conservation practices, but these savings would be made at the expense of future productivity.

The only effective steps that can be taken to reduce the total volume of output are those that shift either capital, or land, or labor resources out of agriculture, or perhaps shift all three. But the preceding discussion indicates that if farming is to be carried on at all, an adequate supply of capital is needed for equipment and for current operations in order to achieve the most effective combination with the land and labor resources that are used in farming at any given time. In fact, many individual farmers have a tendency to invest too little capital with their land and labor resources; and changes in types of farming require new capital investment. This means that the primary steps in reducing the total volume of farm output would have to be taken by shifting either land or labor to other uses.

It is possible of course to use the agricultural land and the labor resources less intensively and to reduce output in that way. Land can be shifted from intertilled crops to lower yielding sod crops, and some lands now in crops can be returned to grazing. Such shifts would reduce output, but farmers tend to resist these changes for the reasons noted later.

Farm work days could be shortened. This would mean that less work would be done per worker. Farmers already have slackened the pace they maintained in wartime and it is highly desirable that they reduce it even further. But more workers are now available on farms, and besides, with further mechanization, the job can be done without working so hard. Consequently the effect on production of a shift to shorter working hours may be more than offset by more workers and more mechanization. In fact, the substitution of mechanical power for animal power increases the labor effectiveness of the farm family so much that pressure usually develops to rent or buy additional land. If more land cannot be obtained an attempt is often made to farm the land more intensively. For example, soybeans are substituted for oats, dairy cattle for beef cattle, and the side-line poultry flock is expanded to an important enterprise in the farm business.

This tendency toward increased production per farm as a result of mechanization usually operates in the direction of more intensive rather than less intensive use of land resources. Therefore, if land is to be shifted from intertilled crops to sod crops, or from cropland to grazing, farmers must be convinced of the profitableness to them of this shift over a period of years. Otherwise public compensation is necessary to bring about such adjustments.

Some of the unproductive lands could be shifted out of arable farming by Government purchase or lease. They could be devoted to grazing or to forestry and recreational uses. Programs of this kind are needed in "fringe areas" of land that are poorly suited for agricultural production. But the total volume of output for human use would be affected only slightly by carrying out such a program in poor-land areas. And public opinion probably would not support a program that would hold productive cropland out of arable farming for any considerable length of time.

It appears that about the only effective means by which the volume of output could be reduced is by a shift of workers from farming to other occupations. That would occur only if employment off the farms were available for those who could not find attractive opportunities in agriculture. This question is discussed later, but it should be noted here that the shift would have to be large enough to result in a net decrease in the number of workers engaged in agriculture. A migration from farms of this magnitude would be unlikely under depression conditions. In fact, there was a net landward movement in the early 1930's.

The conclusion seems inescapable that no forces are now operating, or are likely to appear, that are sufficiently strong to offset much of the effect of the forces that will push agriculture in the direction of high-level production. Individual crop or livestock enterprises could be reduced in volume, either by voluntary shifting to other products or by production-control programs; but other products would be substituted and so total output would not necessarily be affected. To reduce the total volume of farm output without shifting land and labor resources to nonfarm uses would require rigid controls. It would mean onerous restrictions on the use of land and labor in farm production.

Output in Relation to Potential Markets

If the output of farm products for human use is likely to remain high, it becomes necessary to examine the prospective volume in relation to potential markets. As a basis for striking a balance between potential output and potential markets it seems desirable to summarize the main forces back of increased production into two groups. One is the shift from animal to mechanical power. The other is higher production per acre and per animal. New land development would be a third group, but this is likely to be a minor rather than a major factor in increased production. Irrigation of land now in arable farming would come under the heading of increased production per acre.

It appears that the shift to mechanical power will proceed at a rapid pace for several years. But its effect on total output will diminish progressively as horse and mule numbers decline toward minimum levels. This means that increased output will then come mainly from higher production per acre and per animal. The rate of such expansion is dependent upon new advances in technology, and their adoption by farmers.

It seems probable therefore that the rate of increase in production might slow down after the substitution of mechanical power has spent its force. Even the rate of increase for the next few years is not likely to be at the wartime pace, because part of that expansion represented release of production capacity that had been dammed up by drought and depression. But previous discussion indicates that an upward trend should be expected.

On the market side the largest item is the level of domestic consumption of farm products. This depends on the size of the population, and on the purchasing power that is available for consumers to buy farm products. The population of Continental United States is still increasing and with an upward surge in recent years. One is likely to forget that there were about 25 million more people in this country on January 1, 1948 than there were 20 years ago. By 1955, the population is likely to be about 7-8 million larger than in 1948.

When prospective production levels are compared with some prewar period it is necessary therefore to remember that there will be many more consumers of meat, milk and other farm products. A per capita comparison is much more appropriate. Figure 37 shows farm output per capita and cropland per capita by years from 1919 to 1947. Although the cropland per capita declined about one-fourth in that period the level of farm output per capita increased by 10-15 percent. Assuming average weather conditions, the level of output per capita probably would now average about 10 percent higher than in the 1920's.

If exports and imports were maintained at the same levels as in the 1920's, and if output increased only at the same rate as the population increased, the per capita domestic consumption of farm products would need to be only about 10 percent above the level of the 1920's to absorb the total farm output. Food consumption in the 3 years 1945-47 has averaged 15 percent above the level of the 1920's. Consequently it seems quite possible to achieve a level of domestic food consumption that would provide a market for a balanced output of farm products if high employment and purchasing power can be maintained. It should also be feasible to maintain the use of nonfarm food products at higher levels. In the 1920's a large

segment of the population did not have the money to buy food enough for minimum adequacy. Consumption of nonfood farm products also was restricted by the low incomes of some groups. And the export market, although greater than in the 1930's, was not so large an outlet for farm products as it would be possible to develop in an expanding peacetime world economy.

This potential balancing of production and market outlets is dependent upon three factors: (1) Farm output increasing in proportion to the increase in population, (2) maintenance of employment and purchasing power at levels that will support a per capita level of consumption of food and other farm products at least 10 percent above that of the 1920's, and (3) maintenance of at least the same volume of exports as in the 1920's. Any one of these three forces could upset the balance. If a spurt in technological advances should result in a much greater increase in output than in population farm products would press more heavily on market outlets. And if such a spurt should coincide with a period of unemployment the lowering effects on farm prices would be accentuated. On the other hand, maintenance of a high level of employment probably would result in a level of per capita consumption more than 10 percent above the 1920's. Some adjustment is to be expected with the subsidence of the food emergency, but if other sectors of the economy are prosperous the markets are likely to absorb a large volume of farm products.

Although under conditions of prosperity a large volume of farm products might be marketed without heavy downward pressure on farm prices, production of the different commodities would need to be balanced in relation to their respective market outlets. But that is where we are likely to encounter difficulty. Cotton, wheat, potatoes, eggs and oil crops, are potential trouble spots on the farm front after the emergency has subsided. On the other hand, more milk, meat, poultry products, fruits and vegetables would be needed for high level nutrition. And a shift from intertilled crops toward more hay and pasture, which in turn means more livestock, would help to maintain and improve soil resources.

If such shifts could be accomplished we would tend to utilize more effectively the Nation's resources in both land and labor. Beef production is a land-consuming enterprise, and milk, fruits, and vegetables are labor-consuming enterprises. But changes in these directions depend upon a farm price-and-income structure that would make them profitable to farmers. Under conditions of prosperity these adjustments could be made profitable because consumers would have the purchasing power to buy high-priced foods. But if depression conditions should prevail it would be very difficult to shift production in this way.

Adjusting Market Outlets to Balanced Farm Output

This rough balancing of potential production with potential market outlets indicates that the markets could absorb the potential production if conditions were favorable for high-level consumption. But work in market development would have to be undertaken at home. Export channels would need to be kept open. And shifts in production would be needed--in the direction of foods that would be emphasized in a high-level prosperity diet, and toward farm products that would find larger industrial uses, or that could be exported in greater volume.

As markets for farm products can be expanded, and as the total volume of farm output cannot be reduced without severe restrictions on the use of land and labor, it appears that the slogan "Adjust production to market demands" of the interwar years might well be reversed. It was applicable to shifts from commodities that were pressing heavily on market outlets and into the production of others that had a brighter market outlook. But when reduced purchasing power limited the outlets for all farm commodities the real remedy was not to be found in reduced production. If farm workers could have obtained other employment the balance might have been restored by reducing the total output of farm products, but the contracted purchasing power coincided with unemployment in the cities. And this caused a landward rather than a cityward movement of workers.

The experience of the 1930's suggests that neither the supply of, nor the demand for, individual farm products is fixed and immutable as the laws of nature. Each can be modified by human effort, and by man-made institutions. But that experience also suggests that it is less difficult in times of depression to increase the market outlet than it is to reduce the total volume of farm output. And from the standpoint of national welfare, food is needed just as much during depression as during prosperity. In fact, measures are needed to increase food consumption among certain groups of the population, even in prosperous times.

Human distress would be accentuated if farmers were to attempt to reduce the total volume of food output in depression years. But in such periods farmers do need some form of income insurance, or of income floor, that will protect them against disastrously low prices. This would be the farmers' counterpart of minimum wages and unemployment insurance.

Procedures can be developed that will promote a high level of demand for farm products--for domestic food consumption, for industrial uses, and for export. A national goal of adequate food for health available to all citizens, regardless of the state of economic activity, would go far in the

direction of providing stable outlets for farm products. But this requires that public measures be devised to provide adequate food for those who cannot afford it, and that such programs be expanded as needed if depression comes. Education in the elements of good nutrition could be greatly strengthened for all age groups and all income classes, and this also would help in aohieving the goal of adequate food for all.

New uses may greatly enlarge the markets for some farm products in the course of several years. Research in this field holds considerable promise. But it must be clearly recognized that it is not enough merely to discover the physical suitability of a product for the new uses. It must be possible to produce this commodity at a cost that enables it to be sold in competition with substitute products. Price polioies for specific farm products can either promote or retard the development of new market outlets.

International arrangements that permit a large volume of both exports and imports can supply a part of the outlet for farm produots. Export markets for cotton, tobaoco, wheat, and fruits are extremely significant to all farmers, beoause competition in other products will be intensified if these outlets are not available. Perhaps even more signifioant, however, is the indirect effect of international trade in nonfarm products. Exports of automobiles and farm machinery, for example, create domestic employment and therefore increase the purchasing power for food and fiber.

A large volume of exports requires the acceptance of goods and services in exchange. Programs that would protect specific farm products at the sacrifice of greatly expanded world trade would create added competition in the domestic market on the part of farmers whose export markets had been destroyed by the trade restriotions.

Emphasis oan be shifted in the direction of reducing costs or of developing more profitable alternatives for the products that might be injured by freer trade. If by mechanization and increased yields the cost of produoing oil orops can be reduced materially, for example, they oan be grown profitably and in large volume in competition with imported oils. If cost-reduoing measures are not sufficient to achieve this possibility more profitable alternative enterprises need to be developed to replaoe the higher-oost part of the production of domestic oil. Farmers can then shift to those alternatives. Such measures would enable farmers of this country to produce on a low-cost basis in competition with other areas, and to take and to hold the lead in productive efficienoy.

Profitable and Abundant Farm Production

Farmers want to produce both abundantly and profitably. They want to make full economic use of their resources. The nature of farm costs makes abundant production the most profitable use of their resources by individual farmers. But the resulting large output under certain circumstances might lower the prices of some products so much that production would become unprofitable for the entire group of producers.

Individual wheat producers, for example, cannot reduce output without lowering their individual net incomes, but the price-depressing effect of a large crop may reduce the income to all wheat farmers. The case is usually not so clear-cut as this, but it is natural to reach the conclusion that wheat farmers would increase their incomes if they all reduced production by some pro rata amount. At this point, however, the wheat farmer's cost structure should be examined. If through mechanization he already has labor and equipment on his farm that is partly unutilized, a restriction of output means that his overhead costs will have to be carried by a smaller quantity of wheat. Therefore, his average costs per unit of product will increase if production is reduced.

For instance, in the spring-wheat area of northwestern North Dakota and northeastern Montana, a farm family using tractor power and appropriate tillage, seeding, and harvesting equipment can easily handle 800 acres of cropland in an alternate wheat-fallow rotation. This size of farm represents about a minimum from the standpoint of operating efficiency. With an allowance of $1,000 cash income for the operator's labor and management, and a return on investment at prevailing rates, the average cost per bushel of wheat sold on a farm of this size was about 78 cents per bushel at the prices and costs prevailing in 1943. If wheat production had been reduced 20 percent, the average cost per bushel sold would have risen to 90 cents, which is an increase of 12 cents per bushel, because the overhead would have to be carried by a smaller output. The price of wheat would have to be $1.20 per bushel to give the operator the same return as he would have if he grew 20 percent more wheat and sold it at $1 per bushel.

This situation is fairly typical on many farms in this country. It means that if total output is reduced the reduction is made in the part of the output that is produced at the lowest cost per unit. The price of the product therefore would have to rise considerably to offset the loss in income from cutting back on the lower cost part of the output. On typical cash-grain farms in the Corn Belt the volume of production per farm increased 44 percent from 1930-32 to 1944, and the cost per unit of product

on these farms decreased 30 percent, after corrections have been made for all changes in prices paid and received. On hog-beef-raising farms in the Corn Belt the increase in production from 1930-32 to 1944 was 25 percent, and the cost per unit of product dropped 9 percent after correction for price changes. On dairy farms in southern Wisconsin an increase of 36 percent in production was accompanied by a reduction of 13 percent in cost per unit of product.

If typical Corn Belt farmers were to reduce their production 20 percent their costs per unit of product might rise as much as 15 percent, and prices would have to be 15 to 20 percent higher if farmers were to have the same income as they would have with a 20 percent larger output. On the other hand, the Corn Belt farmers who reduced their costs per unit of product another 20 percent by further adoption of improved practices usually could count on immediate gains from two sources: The wider margin between cost and selling price and the larger output per farm that commonly is associated with such improvements.

But if an improved practice results in a large additional output, its adoption by a considerable number of farmers would increase the market supplies of that product. This in turn might mean lower prices, and a shifting of part of the gain away from the producers to other groups. The farmers who can take advantage of improved practices by increasing output per man, however, could retain a large part of the gain from greater efficiency and thus offset the impact of lower prices.

Not all improvements that reduce costs have the effect of increasing output, but many of them do. Hybrid-seed corn is a good example. If adoption of hybrid seed results in a 20-percent increase in corn yields per acre, and 15-percent lower costs per bushel of corn, the farmers who adopt hybrid seed gain a great deal, until adoption becomes general enough to increase market supplies to a point at which lower prices are paid. In the past, the general adoption of improved methods has come so slowly that progressive farmers have retained nearly all their gains for a long time. And if market outlets are expanding, the gains can be held more effectively.

Even when prices do go down as a result of higher production the farmers who use the improvement have the protection of larger output and lower unit costs. It is the farmers who cannot take advantage of cost-reducing improvements who will have lower incomes if the price goes down because of a larger output. The workers who are displaced by a labor-saving improvement also will be disadvantaged unless they can find other and better paying work.

One influential means of making abundant production profitable for a larger group of farmers is to devise educational and other programs that will bring rapid and more general adoption of cost-reducing practices. A dollar saved in cash production expenses is just as important an addition to the farmer's net income as the dollar that originates from sales of the product.

If at the same time that farmers are reducing their costs the market outlets for farm products can be increased--by maintaining a high level of production and purchasing power in the nonfarm sectors of the economy, and by other means--farmers need not fear the tendency of production-increasing improvements to result in lower prices. In fact, they will benefit from both the larger volume of production and the lower cost per unit.

But production within agriculture would still need to be balanced in relation to the needs for different kinds of farm products. The harmonious relationship between conservation and high-level nutrition has been mentioned. However, shifts in the direction of more hay and pasture, that induce production of more milk and meat, need to become the most profitable production alternatives in the areas where such shifts are desirable, if the changes are to be carried out by farmers.

If market forces are not sufficiently strong to bring about the shifts that are needed to achieve the harmonious goals of conservation and high-level nutrition these shifts could be accelerated in two ways. One would be to provide high support prices for milk, meat, fruits, and vegetables. This would encourage shifts in production toward such products. But these are commodities that consumers buy in much larger quantities when their prices are relatively low in relation to consumer purchasing power, so higher prices would cut off the part of the market that would be essential in achieving the goal of high-level nutrition. And the potential shift in this direction would then be severely limited by the smaller market outlet.

The other way to aid farmers in achieving both conservation and desirable shifts in production would be to assist in lowering the cost of producing the products that promote conservation and high-level nutrition. To achieve this, emphasis might be placed on improvements that increase the efficiency of producing these products. Aid might be extended in obtaining lime, fertilizer, legume and grass seeds, and other materials that are needed in working out long-time farm plans for stable, soil-improving farming systems. Establishment of more stable tenure systems would give farm operators greater financial interest in soil maintenance and improvement. Many farmers would need educational assistance and

management guidance also in carrying out such a program. A combination of these measures, as needed on individual farms, would go far toward making the desirable shifts in production the most profitable ones for farmers to carry out.

Special measures might be developed in some areas to capitalize on the potentialities of increasing output per man as mechanization and other improved practices are adopted. As technical progress means that fewer workers are required in agriculture, that a farm family can operate more acres of land and produce more per acre, it also means fewer farms but a larger total output. Table 9 shows the progress in reducing hours of labor in corn, wheat, and cotton from 1900 to 1940. During the war, labor used per unit of product was reduced along the entire farm front. Gross farm production increased 18 percent from 1939 to 1944, but the total man hours expended for the 1944 production were only slightly above those used in 1939. And as there were fewer workers on farms, the production per worker in 1944 was 26 percent above the 1939 level.

Farm production in 1944 used about 3 billion fewer man hours than would have been needed under 1939 production conditions. That represents a saving of 1.5 million man years of work at 2,000 hours per worker. The change is accounted for by (1) lower labor requirements per unit of product resulting from increased crop yields per acre, (2) greater mechanization, (3) some shifting out of high-labor crops such as cotton, (4) saving of livestock labor with increased production, and (5) the spreading of overhead and miscellaneous labor over a larger volume of production.

Figure 38 summarizes the remarkable gains in efficiency that agriculture has made over the last quarter-century. Total physical inputs (farm labor, power, and other resources) per unit of farm products decreased about one-fourth from 1920 to 1945. This means that the cost per unit of producing farm products has decreased about 25 percent in terms of the physical labor, power, fertilizer and other materials that go into farm production.

These accomplishments represent rapid progress, but much more startling changes lie ahead if full advantage is taken of the opportunities for reducing labor requirements and for increasing the output per man. For example, mechanical pickers and flame cultivators may soon make it possible to reduce the man hours used per bale of cotton in many areas from the 191 shown in table 9 for 1940 to about one-fourth that figure. If fairly complete mechanization of the cultivation and harvesting of cotton could be attained, the man hours used per bale of cotton might be reduced to 65 hours, as a national average. This would release 1.6 billion hours of

Table 9.- Average hours of labor used for corn, wheat, and cotton production in 1900, 1920, and 1940

Item	1900	1920	1940
Corn for grain			
Hours per 100 bushels	147	113	83
Yield - bushel	25.9	28.4	30.3
Wheat			
Hours per 100 bushels	108	87	47
Yield - bushel	13.9	13.8	15.9
Cotton			
Hours per bale	283	281	191
Yield - pounds lint	198	160	257

labor on an output of 13 million bales. That is equivalent to about 800,000 man-years of labor at 2,000 hours annually per worker. Expenses per bale of cotton would be greatly reduced. Such a drastic change would probably not come rapidly, but the end result would have a tremendous impact on the South, as well as on the entire national economy.

Changes that would enable agriculture to take full advantage of the potentialities of the new technology would be so sweeping that there is little likelihood that they will ever be completely realized. In many respects this may be fortunate because national welfare cannot be measured solely in terms of efficiency. But it seems apparent that considerable progress in adapting farming to the new technology is desirable and necessary if farmers are to be prosperous.

The distance to be traveled varies greatly by areas and by broad regions. Figure 39 shows the gross farm production per worker by census geographic divisions from 1919 to 1946, compared with the United States average production per worker for the years 1935-39 as a base, or 100 percent. The effects of the drought in the early 1930's and the piling up of workers on farms because of the depression is evident in the curve that shows gross production per worker for the United States. But the influence of drought on production per worker is most evident in the North Central and Mountain divisions.

Gross production per worker in the three Southern divisions has been much lower than the 1935-39 average for the United States throughout the entire period shown in figure 39. These three Southern divisions have had about 50 percent of all the farm workers in the Nation, and have contributed about one-third of the total United States production in most of the interwar and World War II years. With the exception of the drought years, gross production per worker in the West North Central States was 50 to 60 percent above the 1935-39 national average in the interwar period, and it was more than twice that prewar national average in the war years 1942-44. Gross production per worker in the Pacific States has shown a tendency to increase throughout the entire period.

What are some of the causes of such wide geographic variations in gross production per worker? Table 10 gives part of the explanation. The South Atlantic and East South Central States had the lowest gross production per worker in 1944. The acres of cropland, value of land and buildings, and value of livestock per worker, were less than one-half of the national average. And the value of equipment per worker was about one-third of the average for the country as a whole. In other words, the average farm worker in these two Southern divisions had less than half as much land, buildings, and livestock, and had only about one-third as much machinery to help him in his farm-production job as did the average farm worker in the United States.

The figures in table 10 indicate that material increases in production and net income for Southern farm workers largely depend upon (1) more capital investment to provide more land, livestock, machinery, fertilizer, and other capital items per worker and (2) opportunities for nonfarm employment for the young people growing up on farms who will not be needed in farm occupations, and for the workers who will be released from agriculture as mechanization and other improvements gain momentum. These changes are inevitable. They are already under way The only question is how rapidly the transformation will take place.

Readjustments of this kind will create opportunities for farm workers in the South to equal the per capita production and income of farm workers in other regions. But on many farms the change involves shifting from a simple cash-crop type of farming, with hand-and-mule operations, to relatively complex soil-conserving types, that involve forage, pasture, winter cover crops, livestock, mechanical power, and larger farms. This kind of farming requires more management and more mechanical skill for successful operation. In most other areas the shift to mechanization and more complex types of farming has been made gradually, and managerial and mechanical skills have developed as needed. The shift from hand-and-mule operations to the mechanical-power phase is a much more drastic change. It may be retarded by lack of requisite managerial and mechanical skills.

Table 10.- Gross production per worker, and value of land and buildings, livestock and equipment per worker, by census geographic division, 1944 and 1945 1/

Census geographic division	Production per worker, 1944 (U.S.average=100)	Land and buildings per worker, 1945 2/	Livestock per worker, 1945 2/	Equipment per worker, 1945 2/	Total crop-land per worker, 1944
	Percent	Dollars	Dollars	Dollars	Acres
Pacific	154	8,746	826	623	32.3
Mountain	144	6,470	1,820	719	68.2
Western States	150	7,784	1,246	664	47.5
West North Central	162	7,668	1,592	926	91.2
East North Central	132	7,175	1,184	863	44.5
Middle Atlantic	109	3,942	1,018	838	24.2
New England	100	3,960	745	529	17.0
Northern States	139	6,665	1,299	864	58.9
West South Central	71	3,433	616	320	31.7
South Atlantic	63	2,212	343	187	14.5
East South Central	52	1,923	351	177	15.0
Southern States	62	2,519	434	227	20.2
United States	100	4,622	844	513	37.7

1/ Production per worker in 1944 is used because that is the production year reported in the 1945 Census.

2/ From the 1945 Census of Agriculture.

Eventually Southern farmers will learn the new ways of farming even by trial and error methods; but it would be possible to speed up the learning process. A management advisory service could help to overcome the lack of experience with new methods. Such a service could help farmers work out systems of farming that involve the improved methods; and it could also provide some guidance in adopting the new techniques. Encouragement might be given to the organization by farmers of cooperative management associations for employing professional management assistance. Research agencies could render service on this front by establishing test farms where new developments could be tested, and where farmers would see them in operation. Frequently there would also be need for credit programs to provide capital for improvements and for enlarging farms.

Although the readjustments in Southern farming are likely to be more drastic than changes in other areas the same general process is at work elsewhere. Mechanization and other improvements have increased the size of farm that a family can operate. They have also made farming a much more complex business. This means that successful, modern farming requires less brawn and more brains than the farming of a generation ago, and that it takes a large capital investment to become established on the size of farm that a family can easily handle from a labor standpoint. Some farmers will need new sources of credit to obtain farms of adequate size, and to buy the livestock and equipment to operate them. Full-time farms that are too small to utilize mechanical power effectively are likely to be too small to provide a satisfactory living for a farm family.

The farmers who can utilize available assistance in adjusting the type and size of their operations to the new techniques are likely to be rewarded with incomes that compare favorably with earnings in other occupations. And such rewards are necessary if farming is to attract a proportionate share of the capable youth who are choosing their life occupations.

But it should be recognized that there are large groups of farm people who cannot benefit from mechanization and associated improvements. There are those who are best fitted for farm work, but who cannot readily adapt themselves to the new techniques. Many in this group are older people who look forward to retirement; but some younger workers will not be able to operate farms of the size and complexity required by the new techniques. Perhaps this group can develop relatively simple types of farming which, even though somewhat less profitable, are better suited for their capacities. Some will find their best opportunities as hired farm workers. Better housing and more adequate security are problems of major importance to the hired-labor groups.

The largest group among those who are likely to be disadvantaged by the more complete shift to the mechanical-power phase and associated improvements are the ones who will need to seek employment elsewhere because their work will no longer be needed in agriculture. If high industrial activity is maintained, other work will be available. But even so, the shift to new work and new environment will be difficult. Employment offices in rural areas will be needed to inform workers of job opportunities. Many of those no longer needed on the farms will require preliminary training for other occupations.

Modern transportation makes it possible for more people to combine rural living with nonfarm work. It would therefore be possible to expand the number of part-time farms and rural homes at the same time that many workers shift to nonfarm employment for their major source of income.

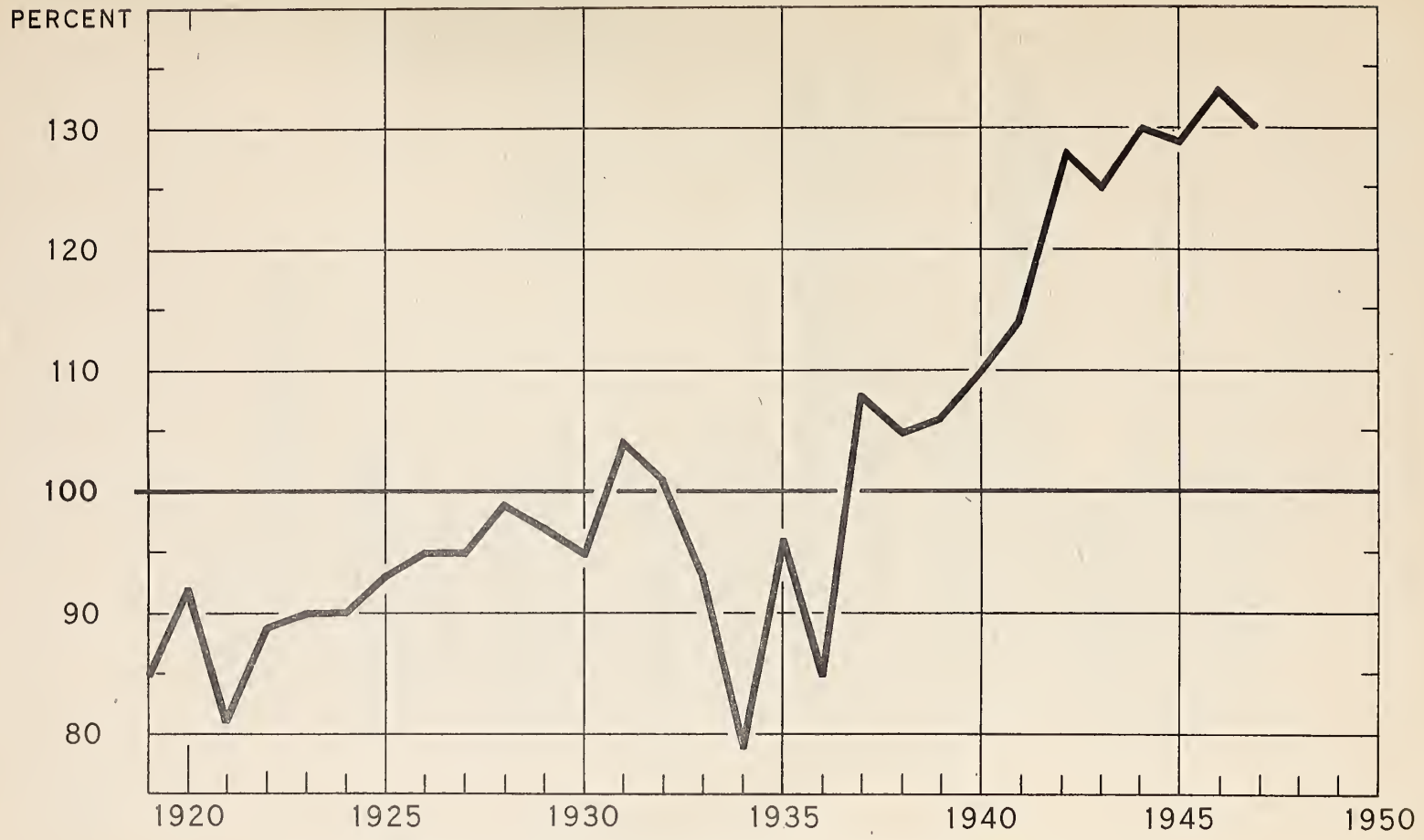
A high level of economic activity will need to be maintained if the workers displaced in agriculture are to be absorbed in other occupations. Figure 6 indicates that progress in technology has increased output per man in other industries in the same way as in agriculture. This means that a market must be found for a greatly increased industrial output. To a very large extent, increased employment at high wages can create its own market, if consumers are permitted to share the benefits of improvement in the form of lower prices. But as output from the productive plant of this country is increased it may become highly desirable to shift more effort into the service occupations--into the health and educational professions, into recreation, and into other professions and services that will provide better living for all the people.

A high level of production is not an end in itself. It is only one of the means to achievement of a better way of living. As increased efficiency is developed in both agriculture and industry less work will be required to produce both food and other products. More time will be available for other things including increased leisure and recreation.

Farmers can retain for themselves some of the real benefits from agricultural improvement if they will take effective steps to utilize the first results. These steps include (1) slackening the pace of farm work and increasing the leisure time available for the entire farm family, (2) investing increased earnings in education and health, and in home conveniences, and (3) refraining from capitalizing increased earnings into higher land values, which make the business of farming more hazardous and less profitable for themselves and for their children. Better farming should mean better living.

FARM OUTPUT, UNITED STATES, 1919-47*

INDEX NUMBERS (1935-39=100)



*FARM OUTPUT MEASURES PRODUCTION OF PRODUCTS FOR HUMAN USE
DATA FOR 1946 AND 1947 ARE PRELIMINARY

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Figure 1.- Farm output in the war years 1942-44 was 28 percent higher than in the prewar years 1935-39. The output in 1946 was 33 percent above prewar.

PRODUCTION OF SELECTED AGRICULTURAL COMMODITIES IN THE UNITED STATES

PREWAR (1935-39 AV.) AND WARTIME (1942-44 AV.) AND 1947

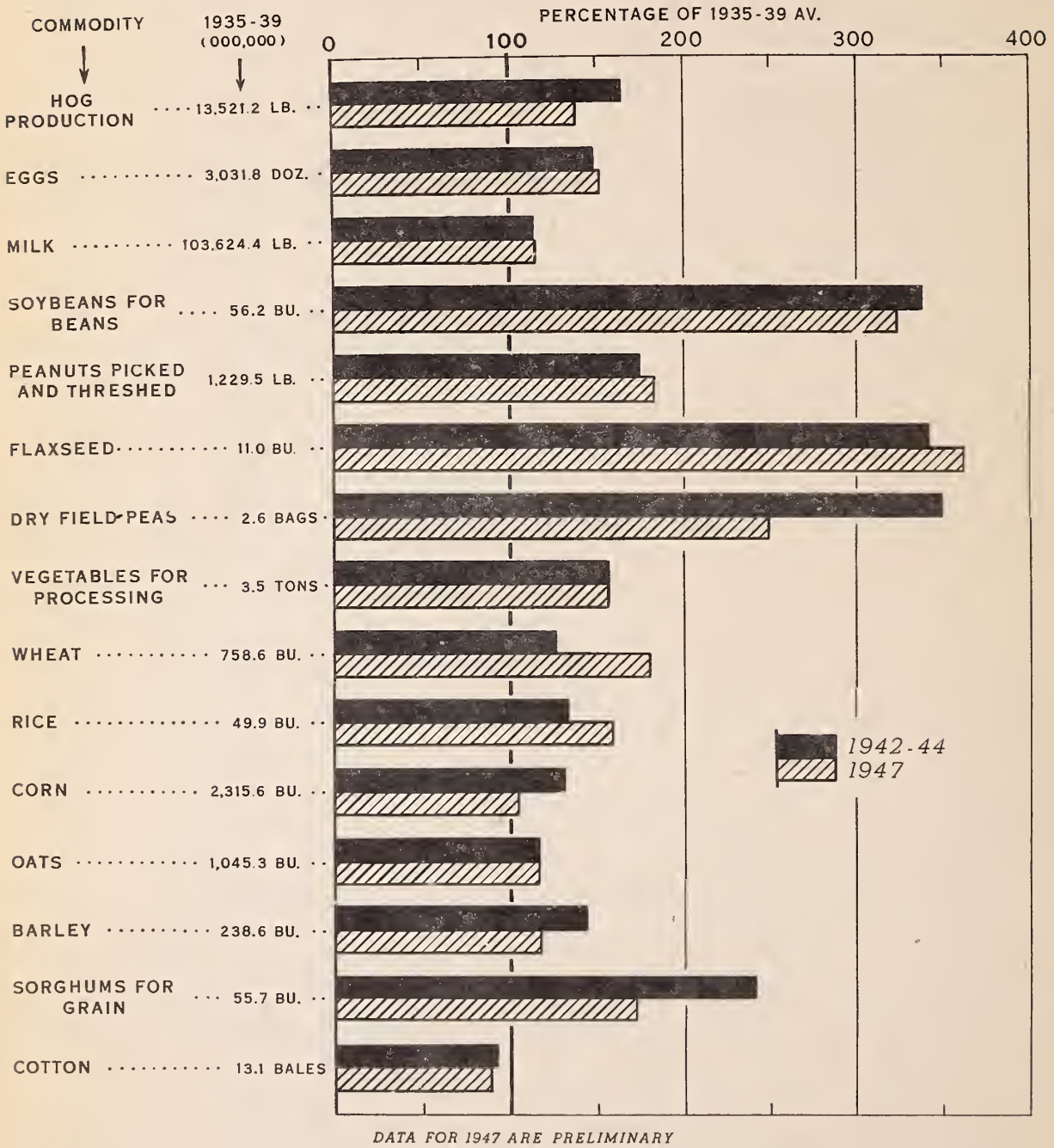
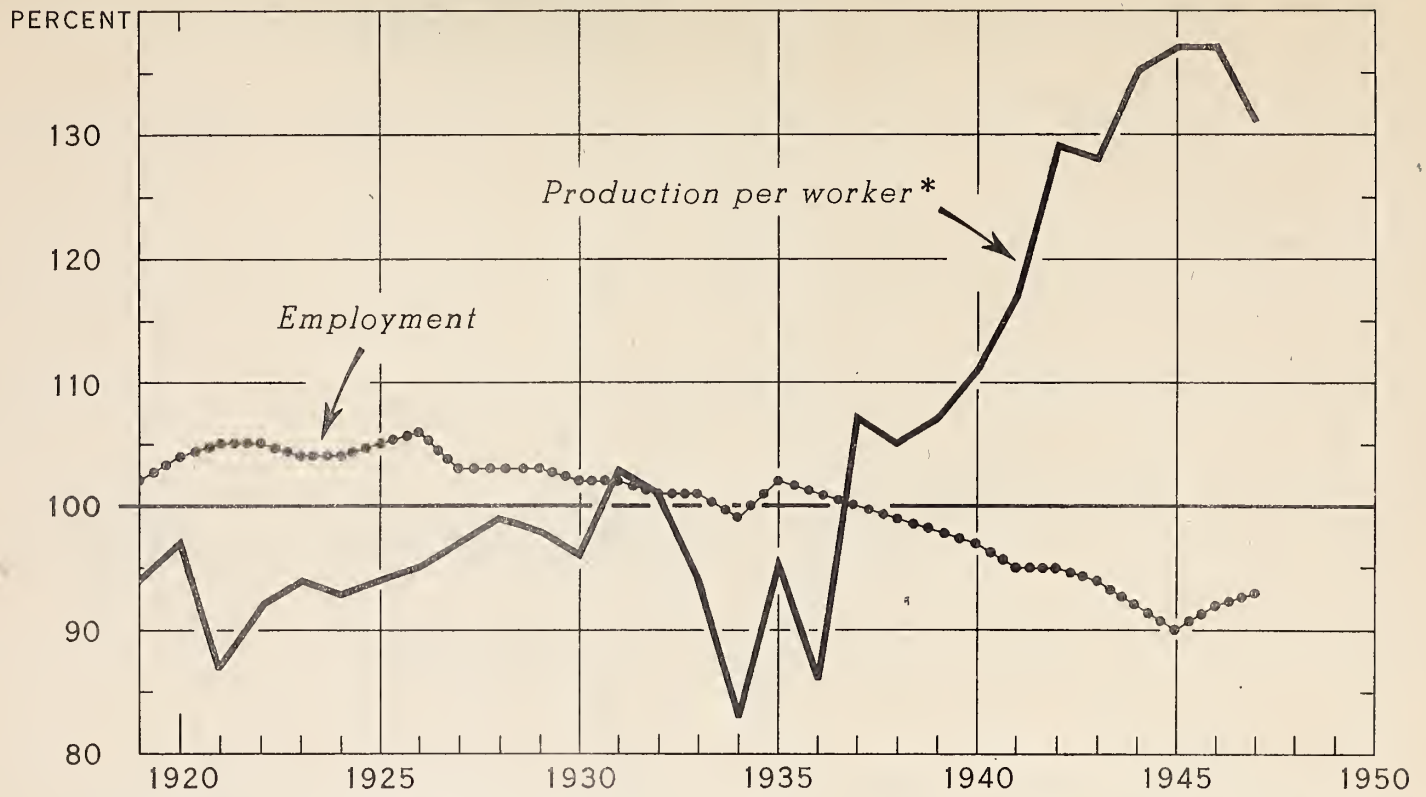


Figure 2.- Production of nearly all the principal agricultural commodities increased in the war years. The sharp advances in oil crops reflect responses to the acute need for fats and oils. The phenomenal increase indicated for dry field peas is of less over-all importance than some of the smaller percentage increases registered from a larger prewar base such as those for eggs and milk. Wheat production in 1947 was the highest on record.

FARM EMPLOYMENT, AND GROSS FARM PRODUCTION PER WORKER, UNITED STATES, 1919-47

INDEX NUMBERS (1935-39=100)



*GROSS FARM PRODUCTION MEASURES THE TOTAL PRODUCT OBTAINED FROM FARM LAND AND FARM LABOR RESOURCES IN EACH CALENDAR YEAR. FARM-PRODUCED POWER, WHICH IS MEASURED BY THE COST IN 1935-39 AVERAGE DOLLARS OF RAISING AND MAINTAINING FARM HORSES AND MULES, IS INCLUDED IN GROSS FARM PRODUCTION BUT IS EXCLUDED IN MEASURING FARM OUTPUT

DATA FOR 1946 AND 1947 ARE PRELIMINARY

U. S. DEPARTMENT OF AGRICULTURE NEG. 45547-A BUREAU OF AGRICULTURAL ECONOMICS

Figure 3.- Acceleration during the war of the long-time downward trend in farm employment, coupled with marked wartime increases in farm production, resulted in record levels of production per farm worker.

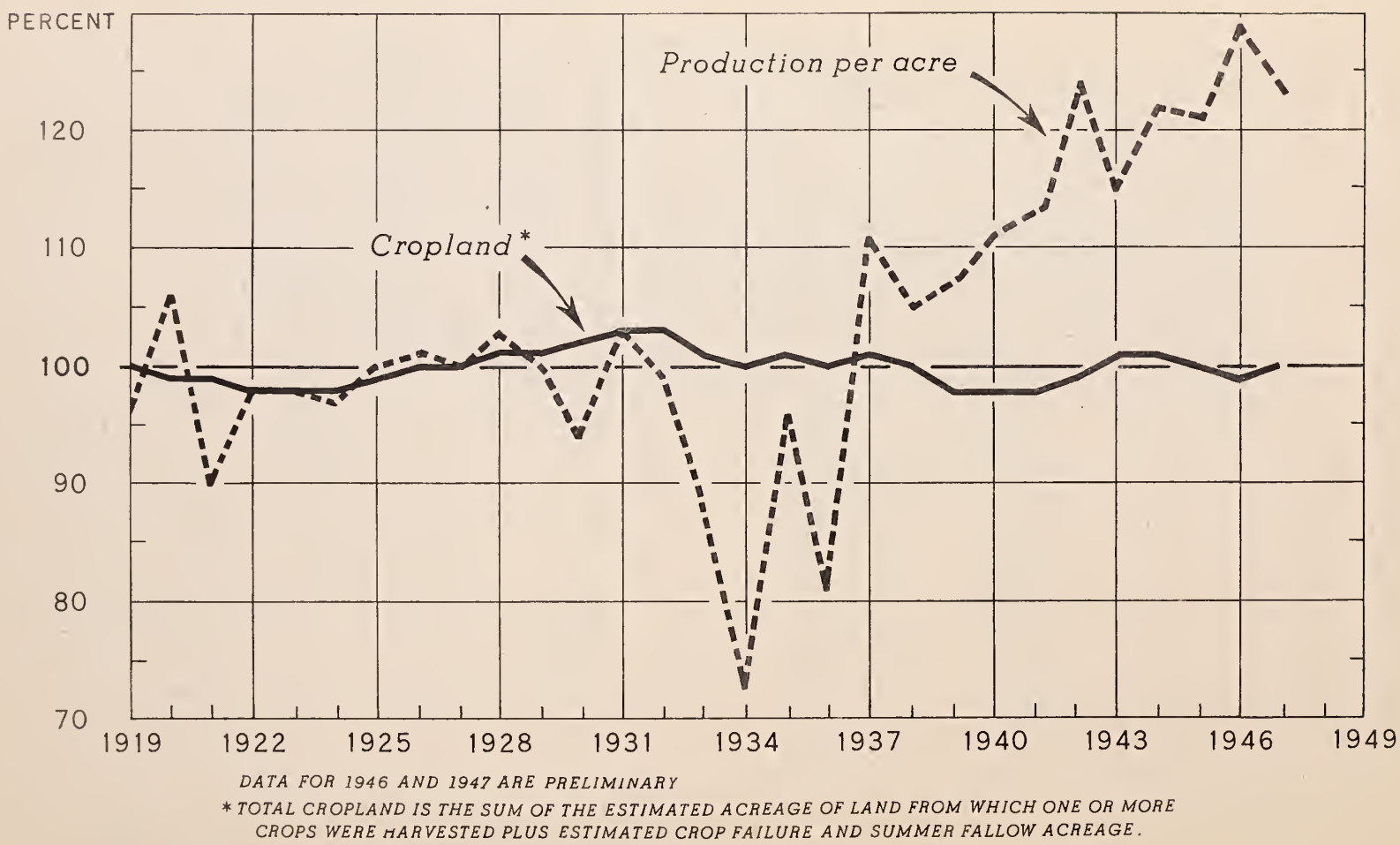


Figure 4.- Increased crop production per acre was by far the most important single factor responsible for record wartime farm production. Total cropland has changed very little during the entire period.

ANIMAL UNITS OF BREEDING LIVESTOCK AND LIVESTOCK PRODUCTION PER BREEDING UNIT, 1919-47*

INDEX NUMBERS (1935-39=100)

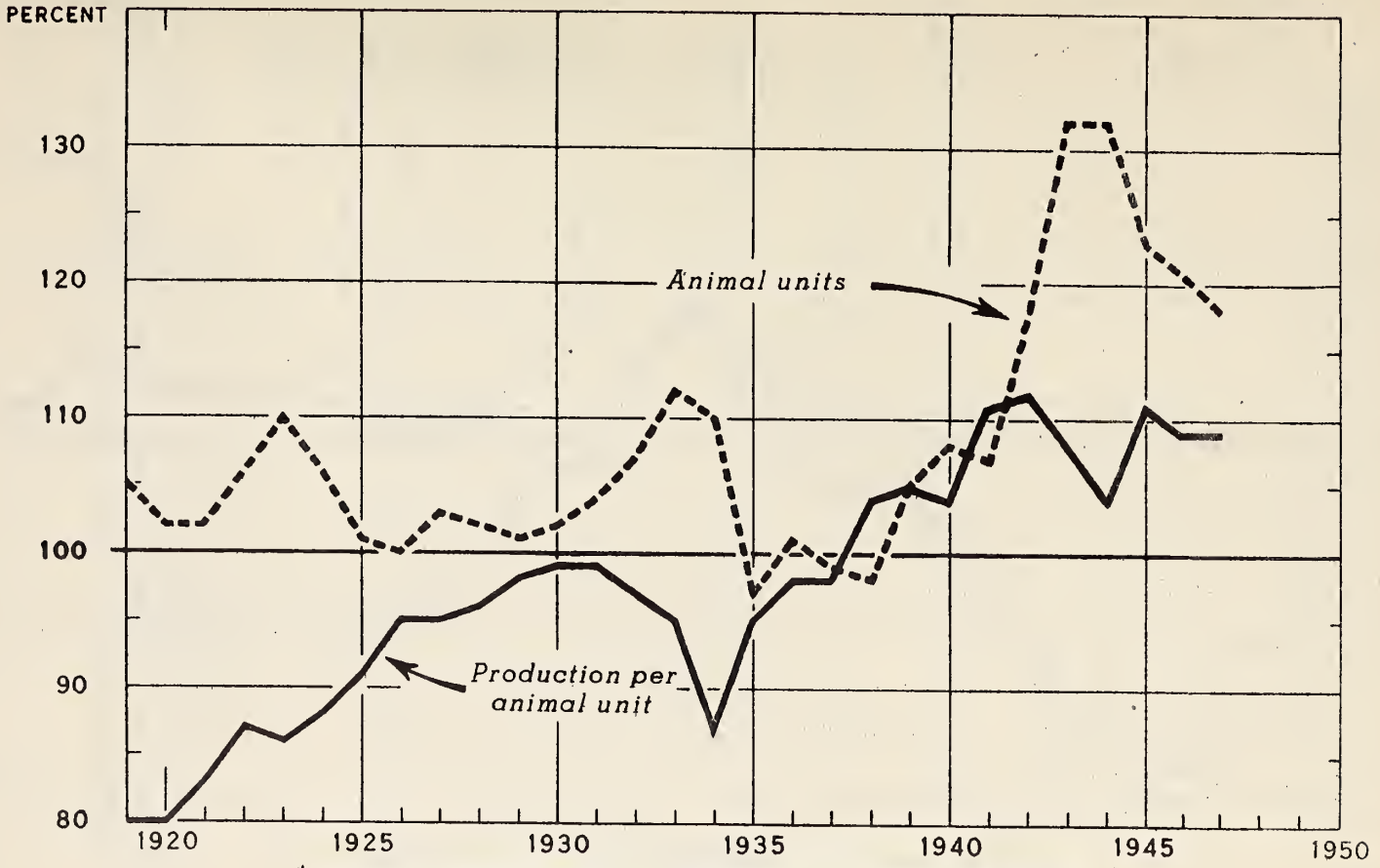


Figure 5.- Livestock production per animal unit of breeding stock has shown an upward trend since 1920, and the animal units of breeding livestock also have increased. The larger volume of livestock production therefore has resulted both from increases in number of breeding animal units and in production per unit.

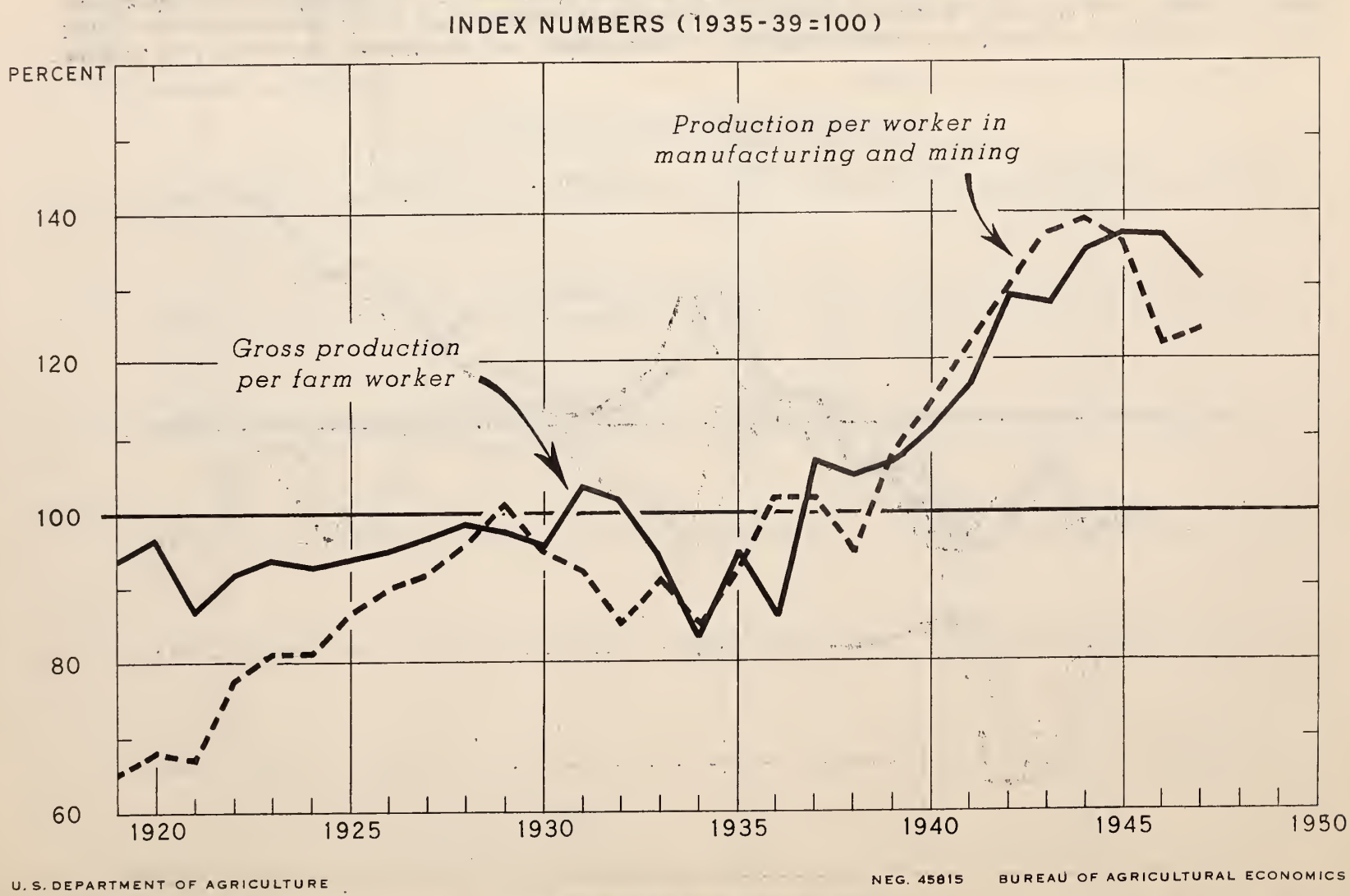


Figure 6.- Increases in production per worker in agriculture matched those of industrial workers during the war, and have remained at a relatively higher level; but production per worker in industry has risen more rapidly than that of farm workers over the last quarter-century.

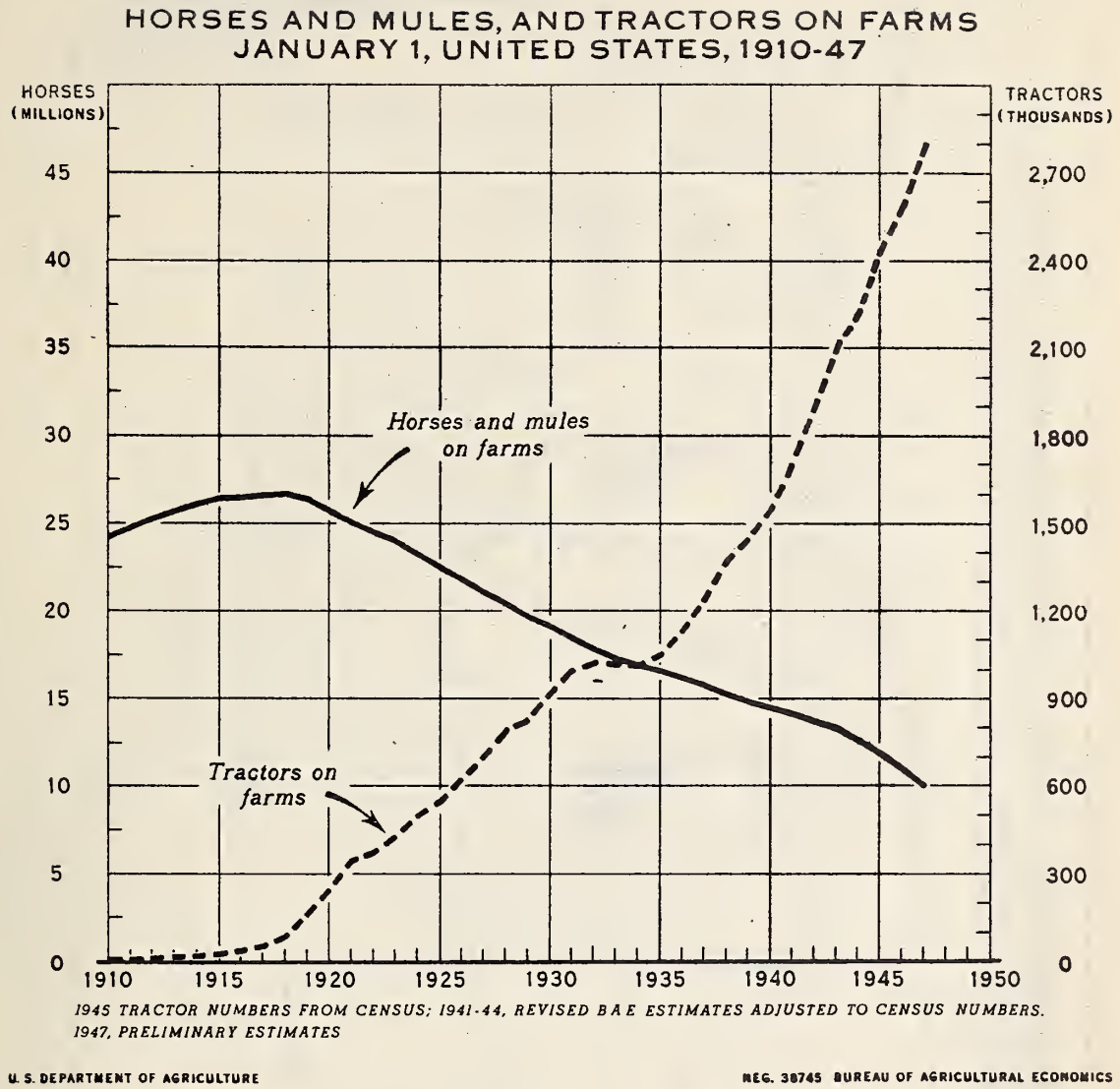


Figure 7.- Tractors have rapidly been replacing animal power for farm production. The number of tractors on farms increased sharply during World War I and in the 1920's. This trend was interrupted in the drought and depression years 1931-35 but was resumed in the late 1930's and has continued in the 1940's.

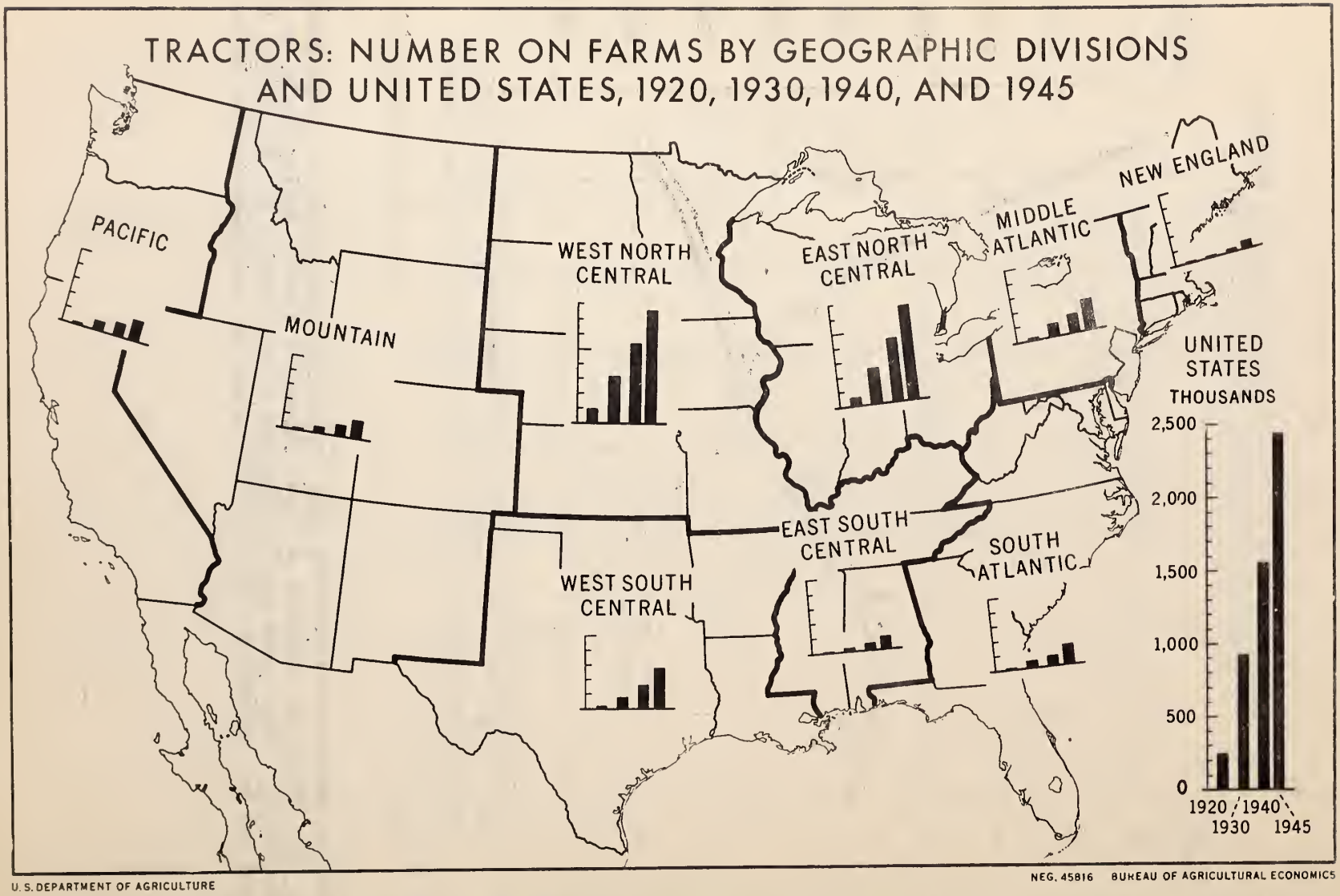


Figure 8.- The shift from horses and mules to tractors took place earlier in the Midwest and the West than in the Northeast and the South.

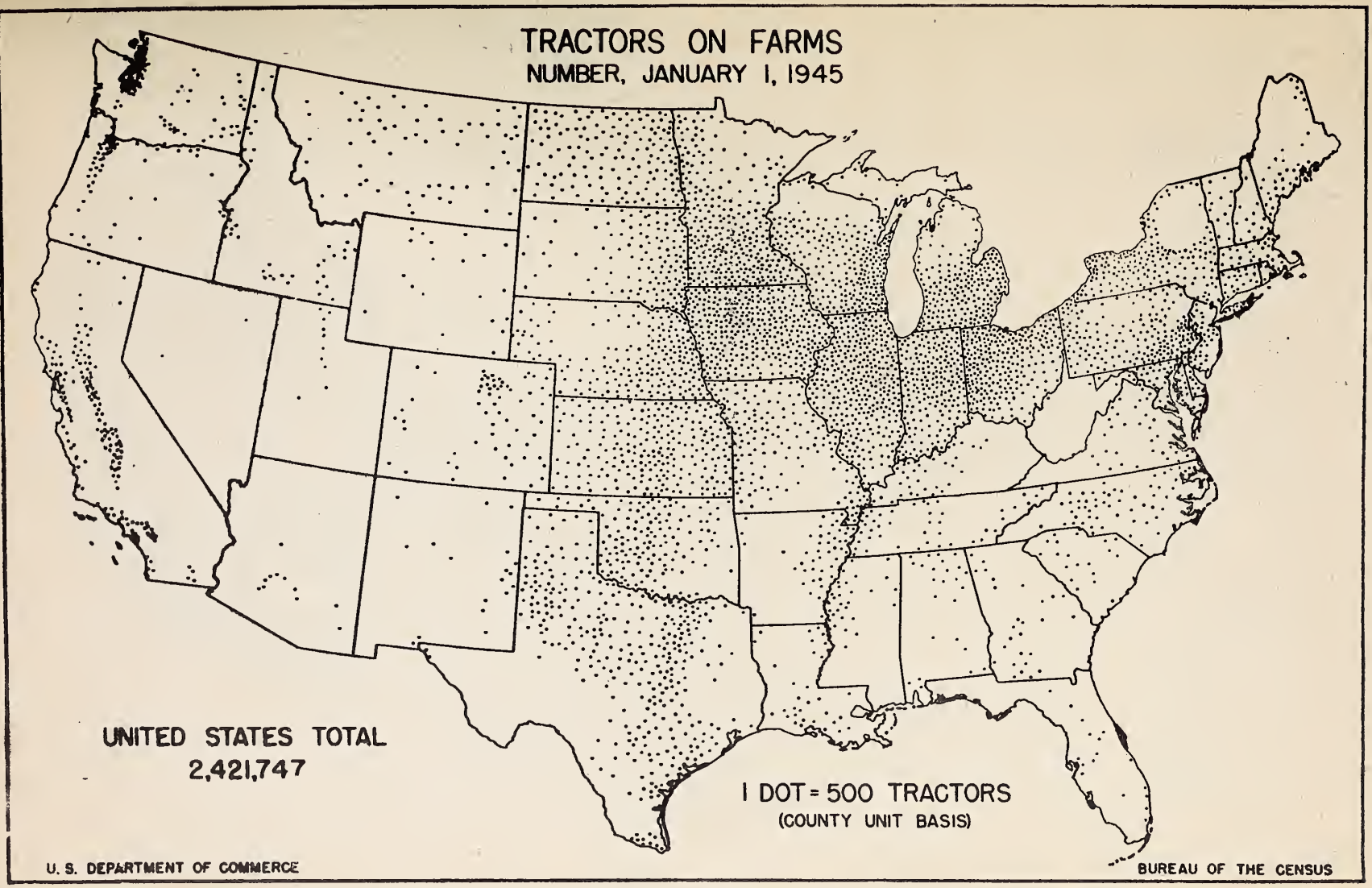


Figure 9.- The greatest concentration of tractors in the country in 1945 was in the Midwest; some smaller areas in other parts of the country also showed heavy concentration of tractors.

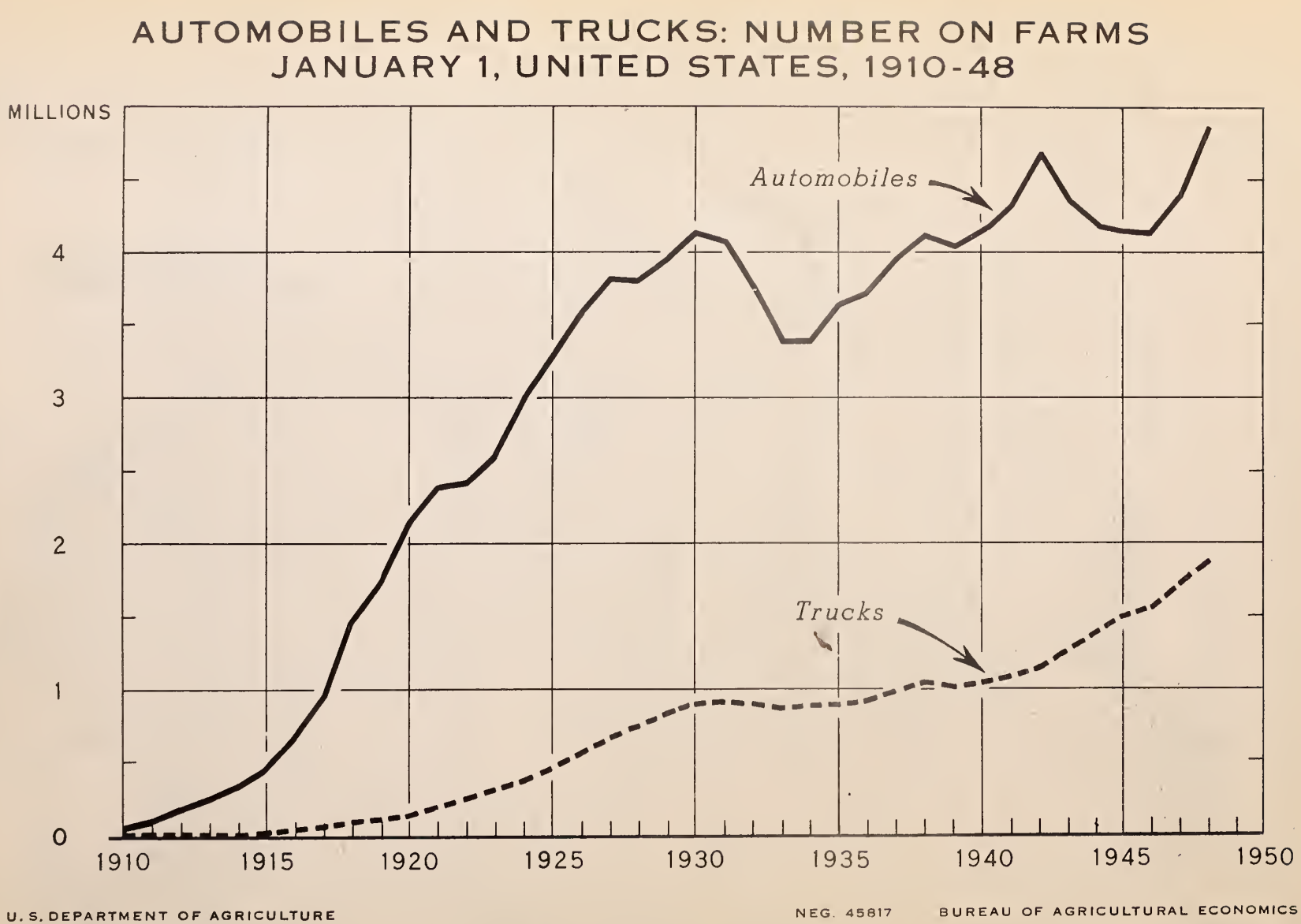


Figure 10.- Automobiles and trucks on farms have increased in the same way as tractors, except for the depression years and for the decline in numbers of automobiles during World War II.

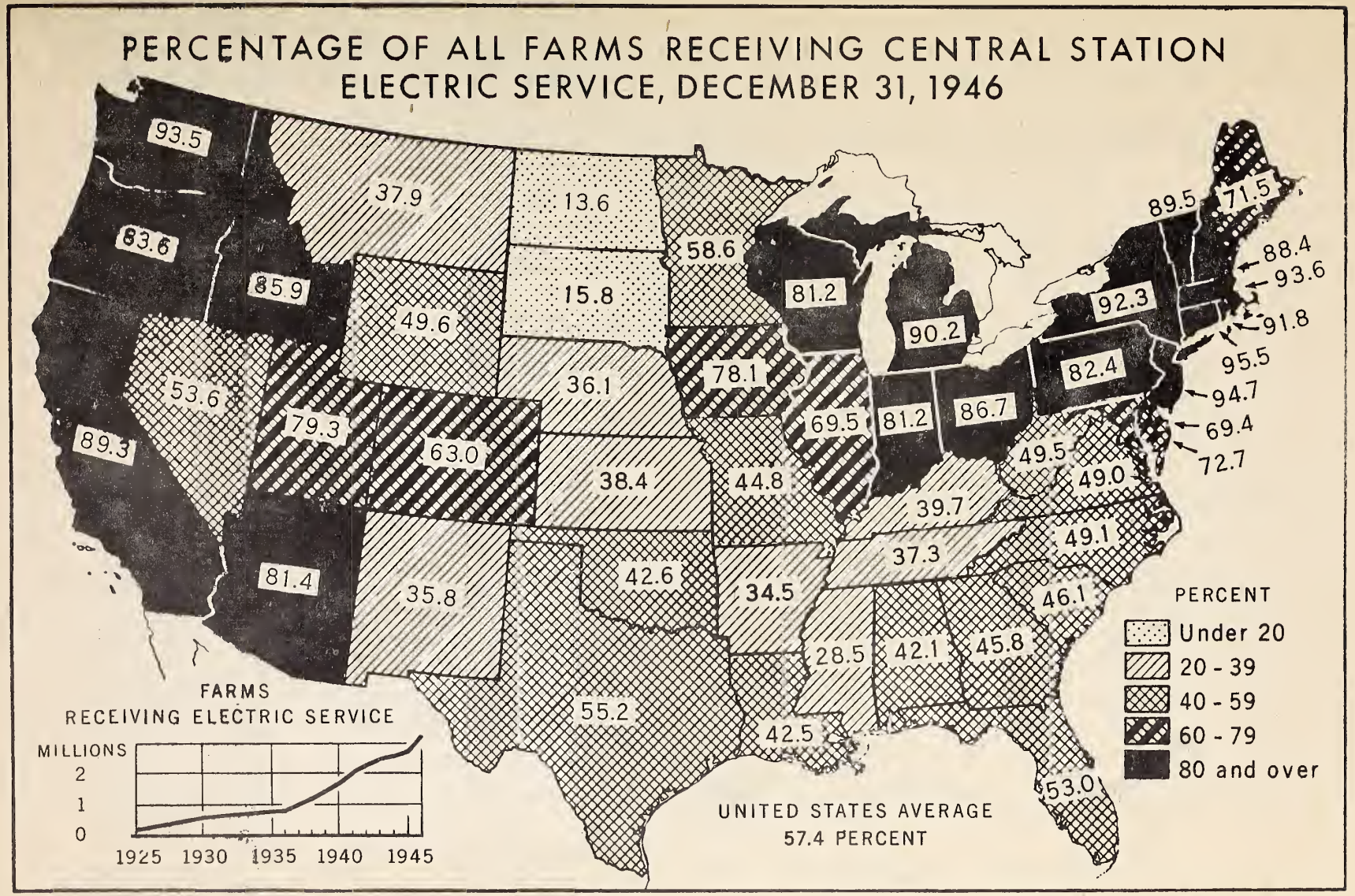


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Figure 11.- Extension of central-station electric service has been greatly accelerated since 1936. The act creating the Rural Electrification Administration was passed in May of that year.

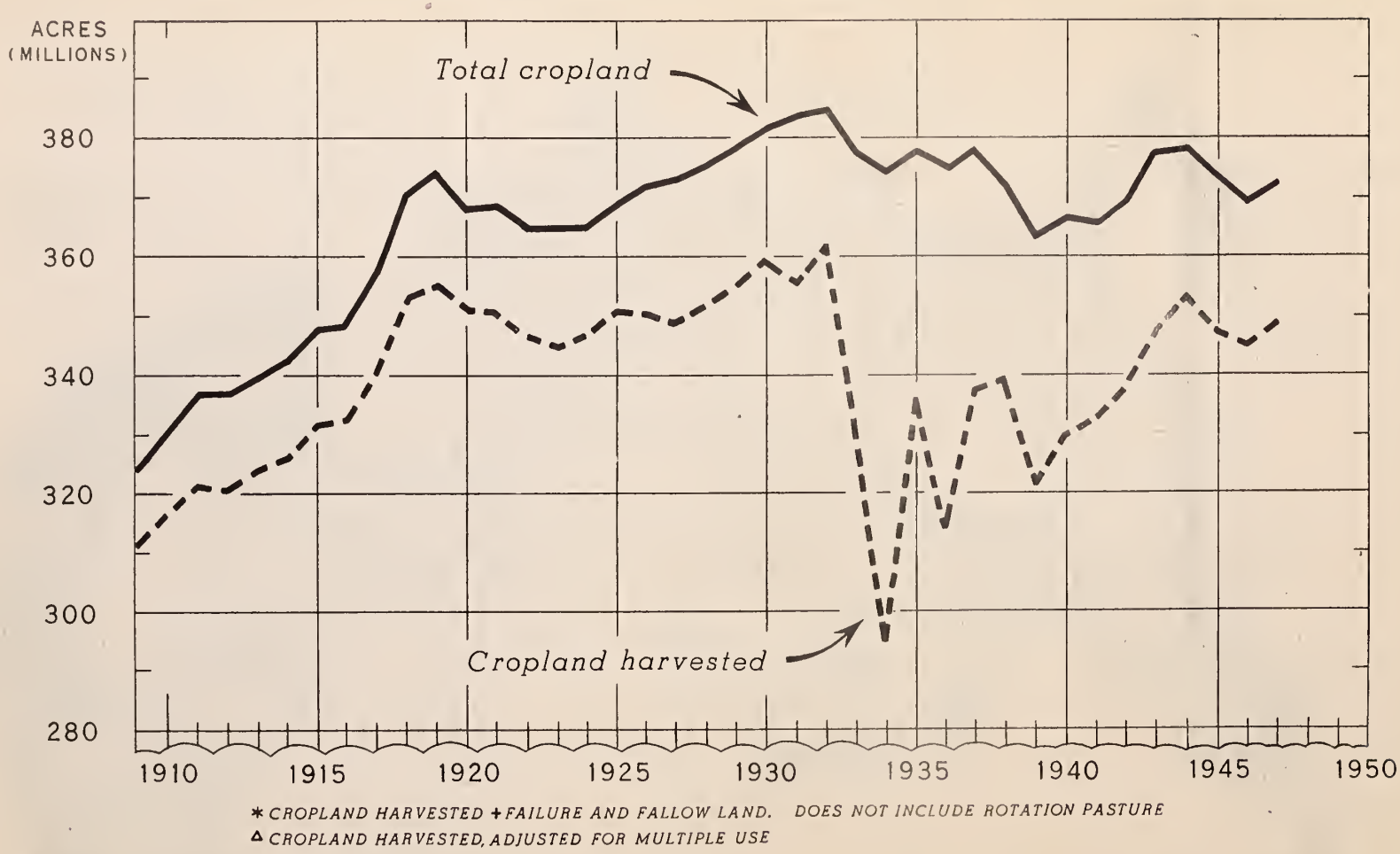

Figure 12.- Total cropland acreage increased substantially in the decade preceding World War I, and moderately in the first postwar decade. During World War II cropland acreage was approximately the same as in World War I.

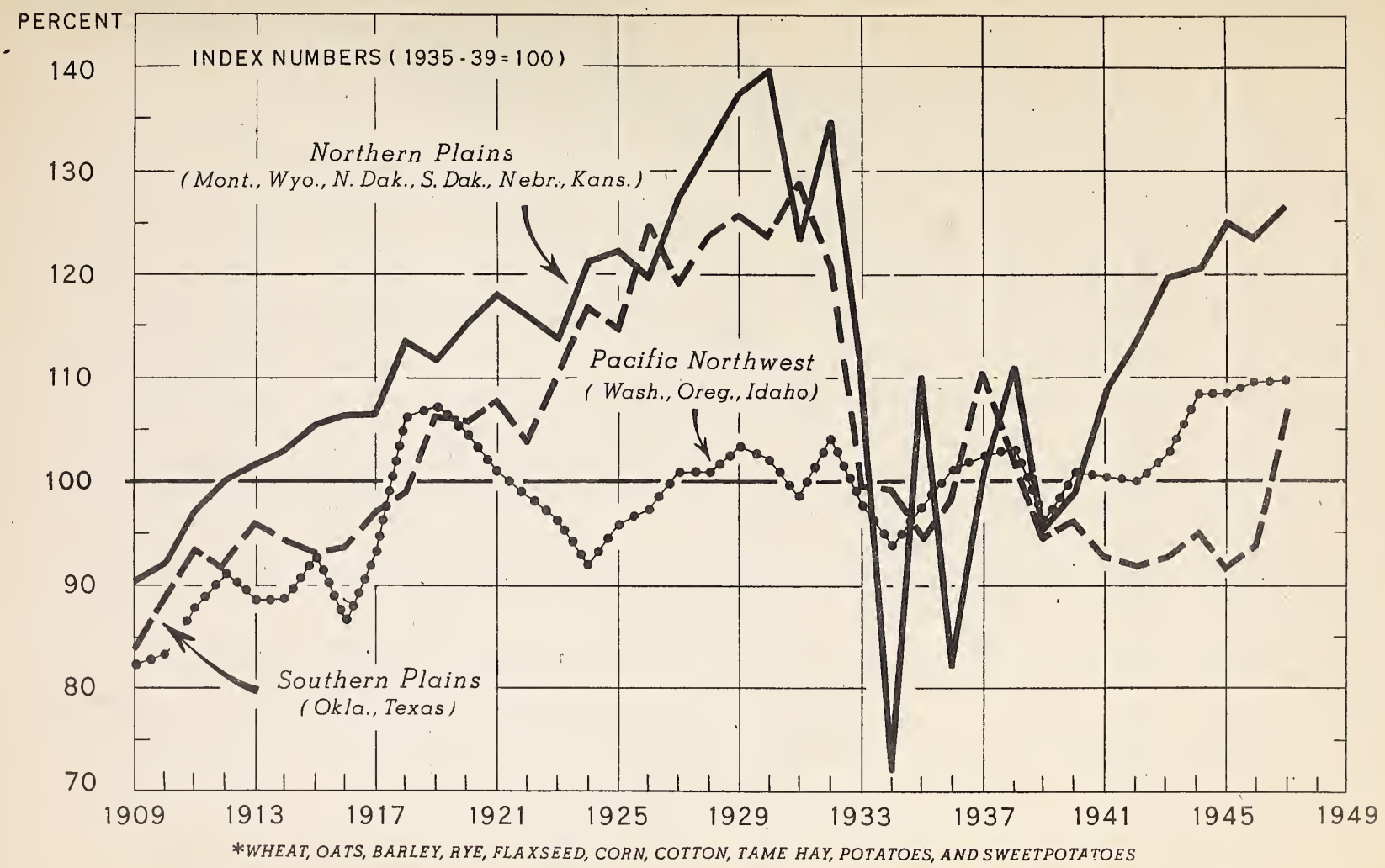

Figure 13.- The acreage of principal crops in both Northern and Southern Plains was higher following World War I than levels reached at any time during World War II.

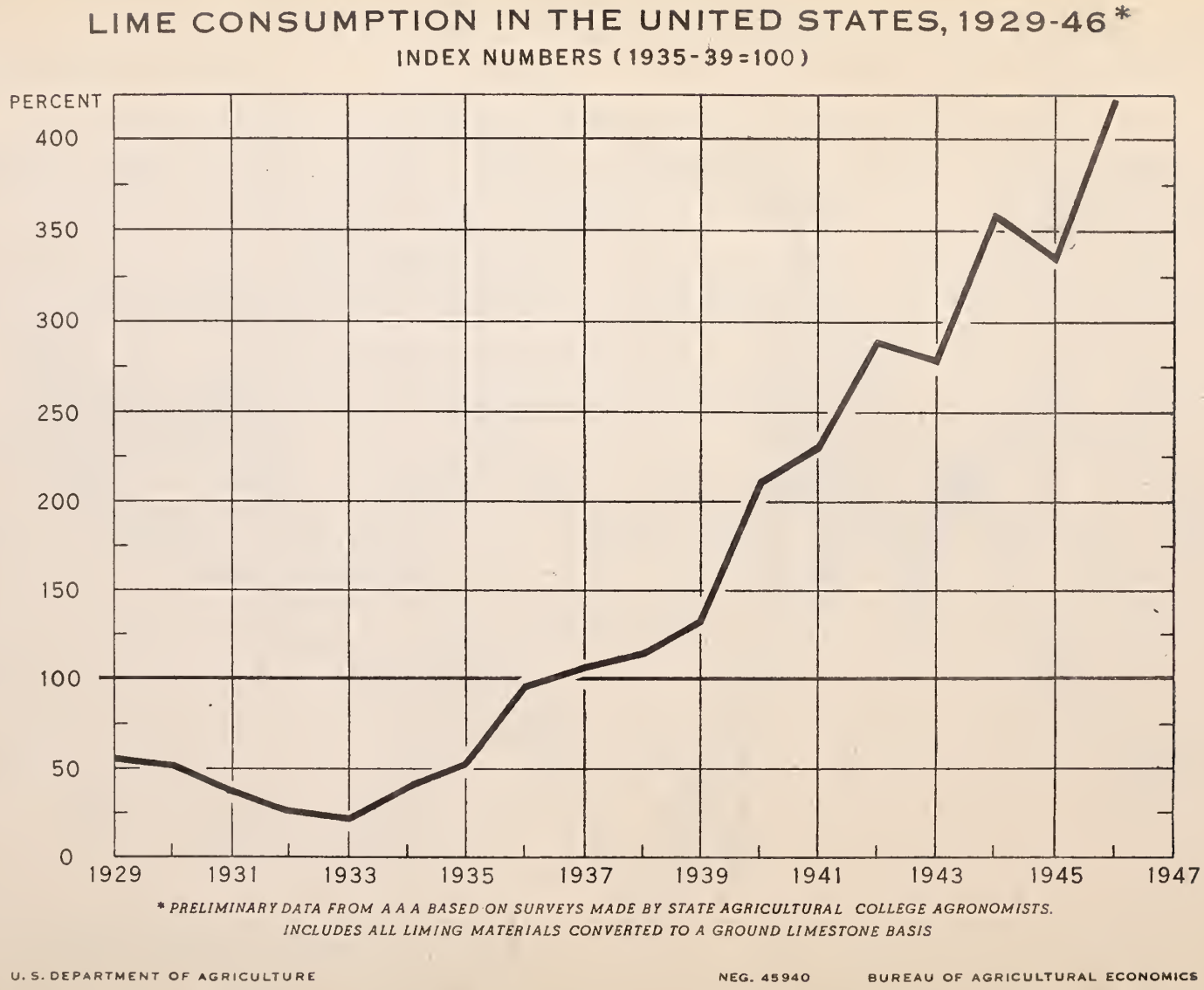

Figure 14.- Application of liming materials rose to predepression levels by 1935. Most of the increase in the use of lime since 1936 can be attributed to the stimulation provided by its inclusion as a conservation material in the Agricultural Conservation Program.

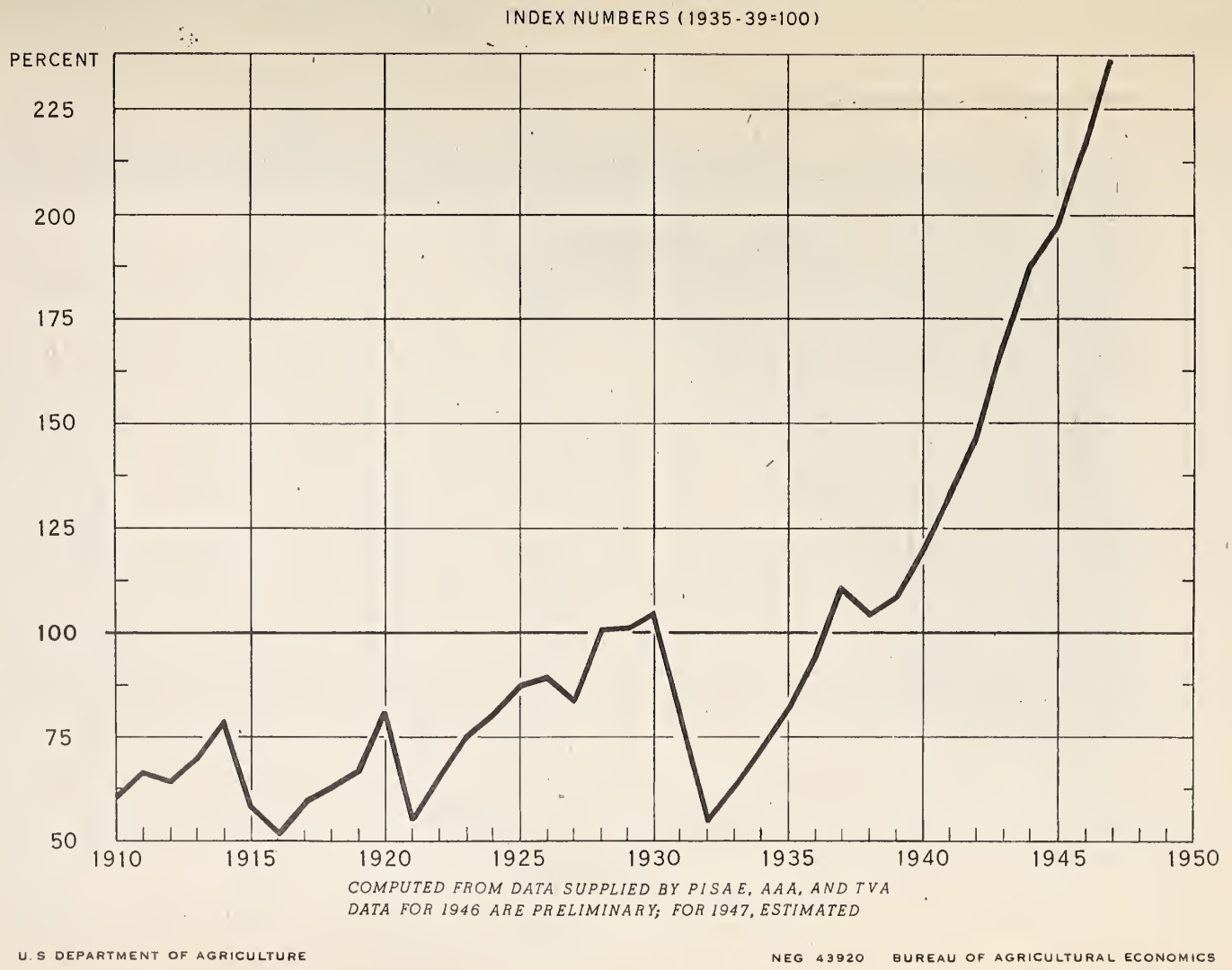

Figure 15.- Use of nitrogen, phosphoric acid, and potash as fertilizer during World War II reached a level nearly double that of the 1935-39 average, and the use has continued to increase since the end of the war. The highest consumption before 1937 occurred in 1930, when the level reached was 5 percent above the average of the years 1935-39.

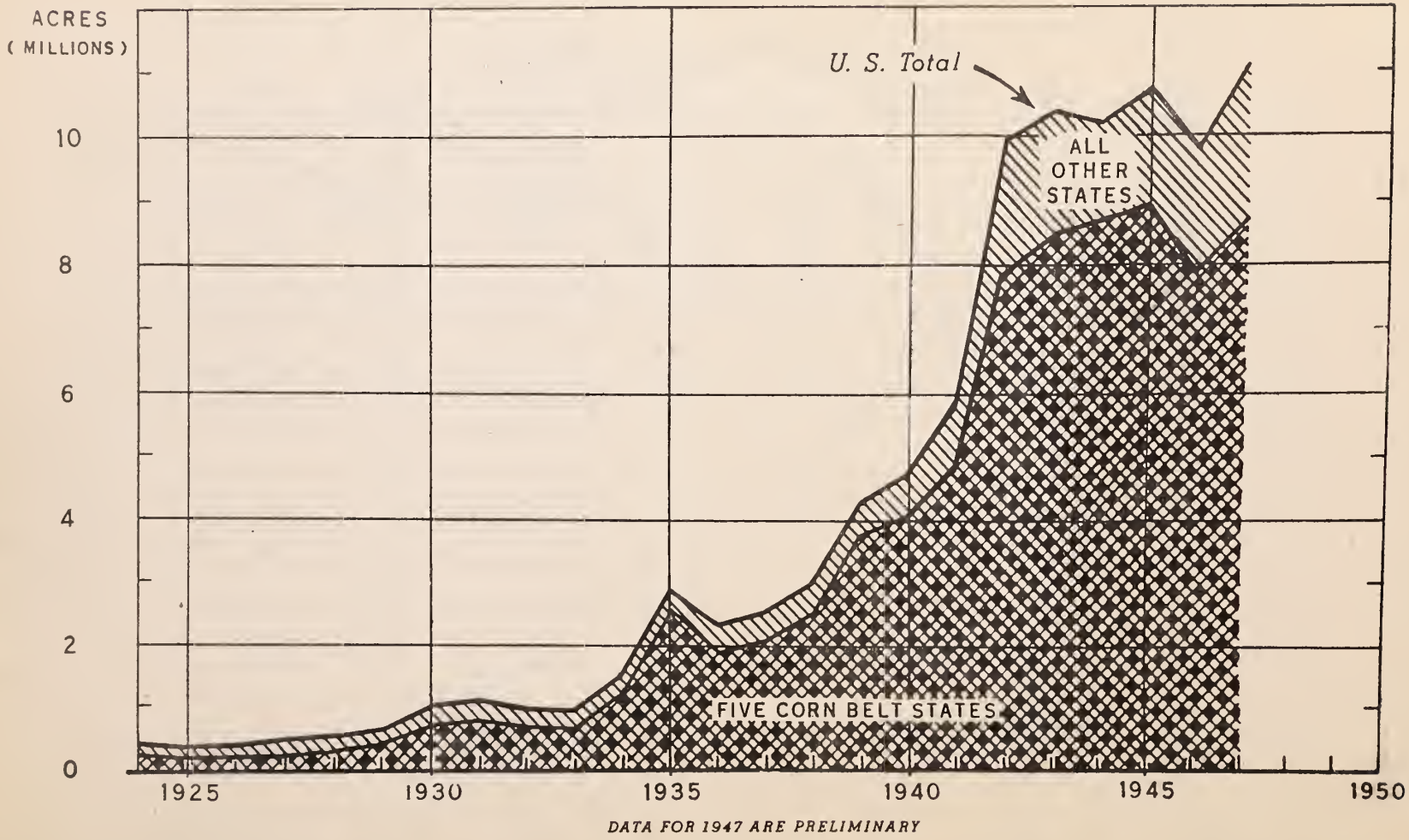

Figure 16.- The acreage of soybeans harvested for beans in the United States increased gradually from less than a half-million acres in 1924 to about a million acres in the early 1930's and then rose sharply. The wartime level exceeded 10 million acres.

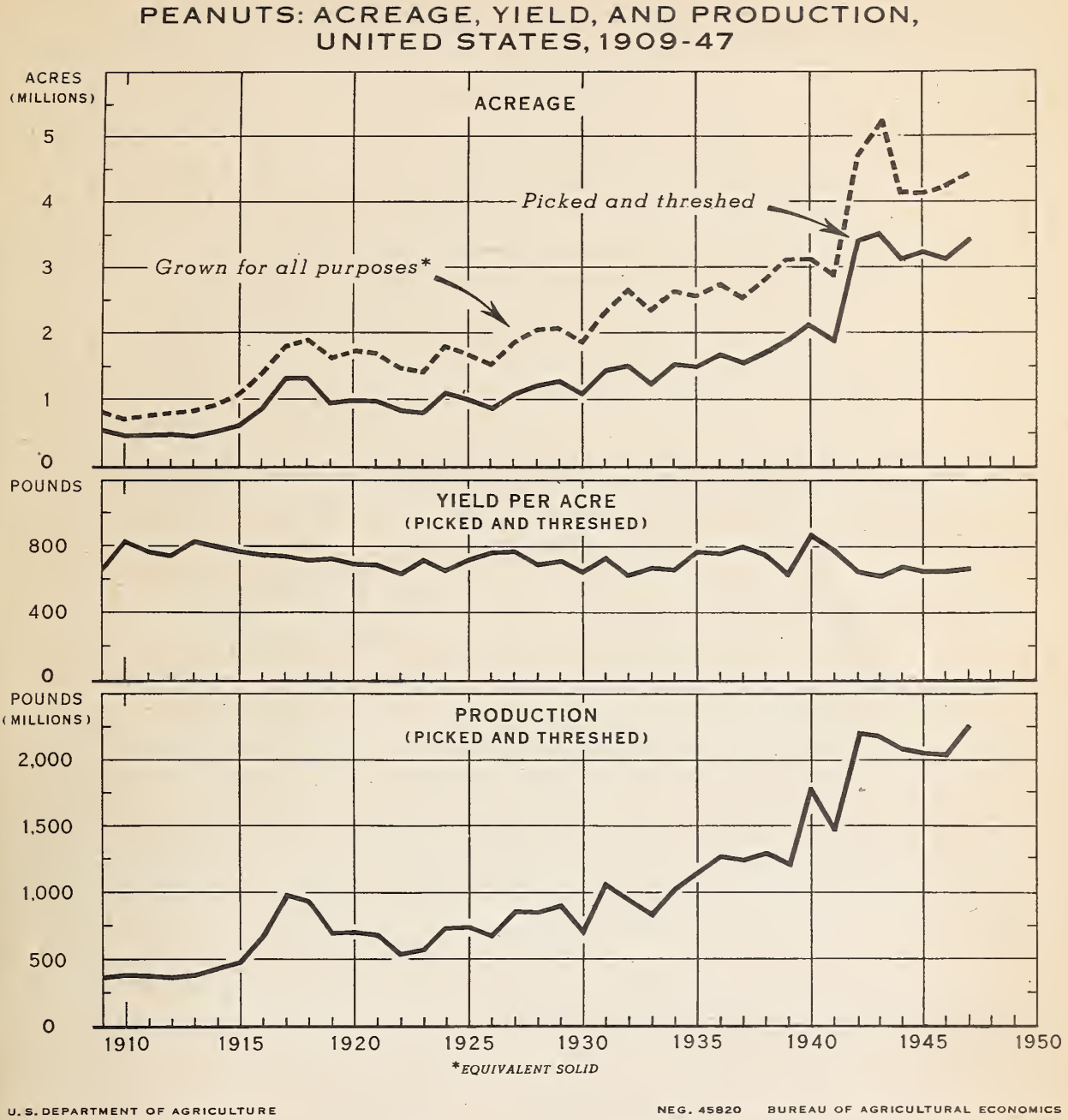

Figure 17.- The acreage of peanuts, picked and threshed, nearly doubled during the war, following the more gradual upward trend of the interwar years. War-time production did not rise quite so much as acreage because yields declined slightly with expansion into new areas, and on farms of new growers in old areas.

PEANUTS PICKED AND THRESHED: ACREAGE, YIELD, AND PRODUCTION, BY AREAS, UNITED STATES, 1909-47

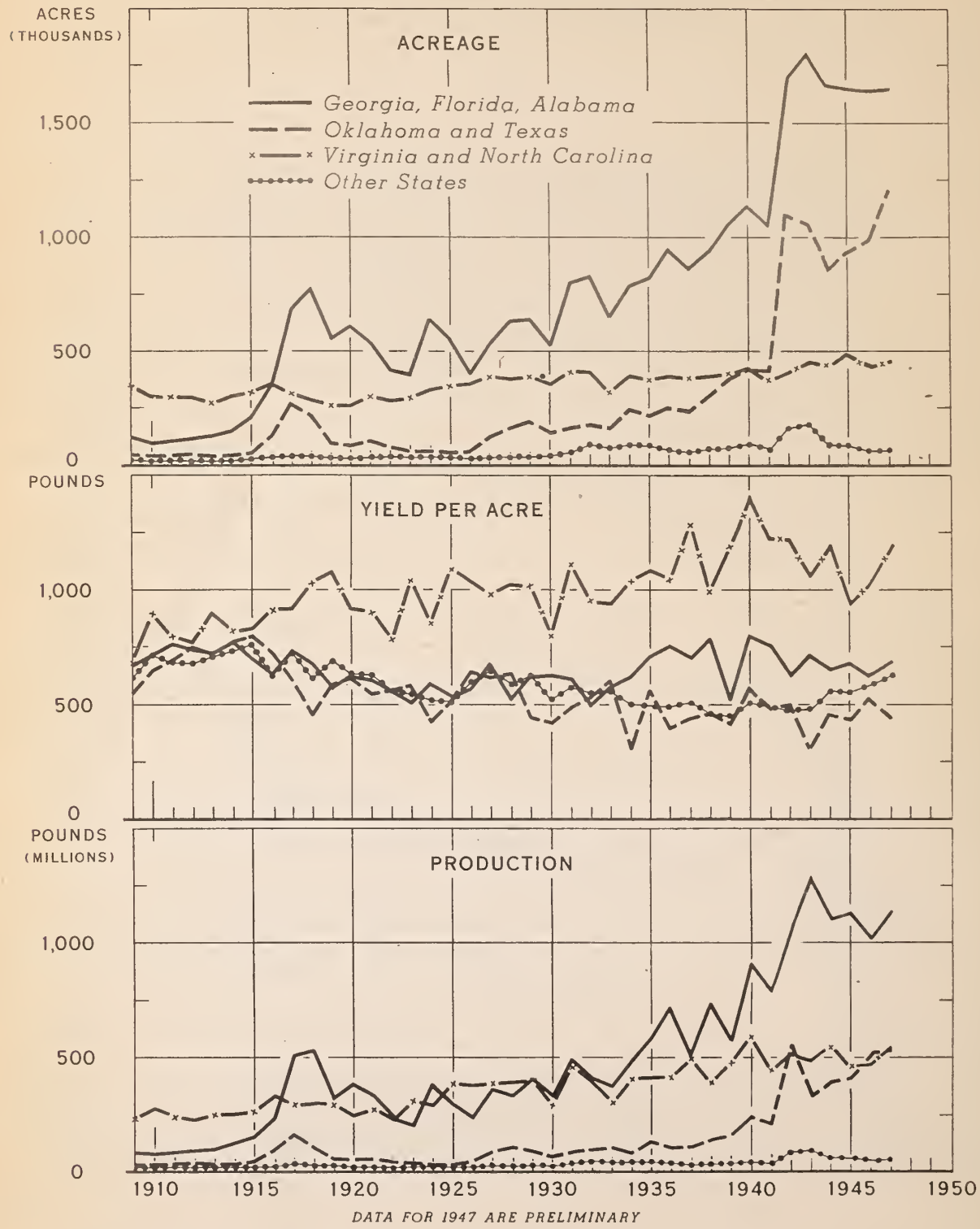

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Figure 18.- Both the long-time upward trend and the wartime increases in acreage and production of peanuts were more pronounced in the Old Area of the southeast and in the Oklahoma and Texas Area than in the other areas.

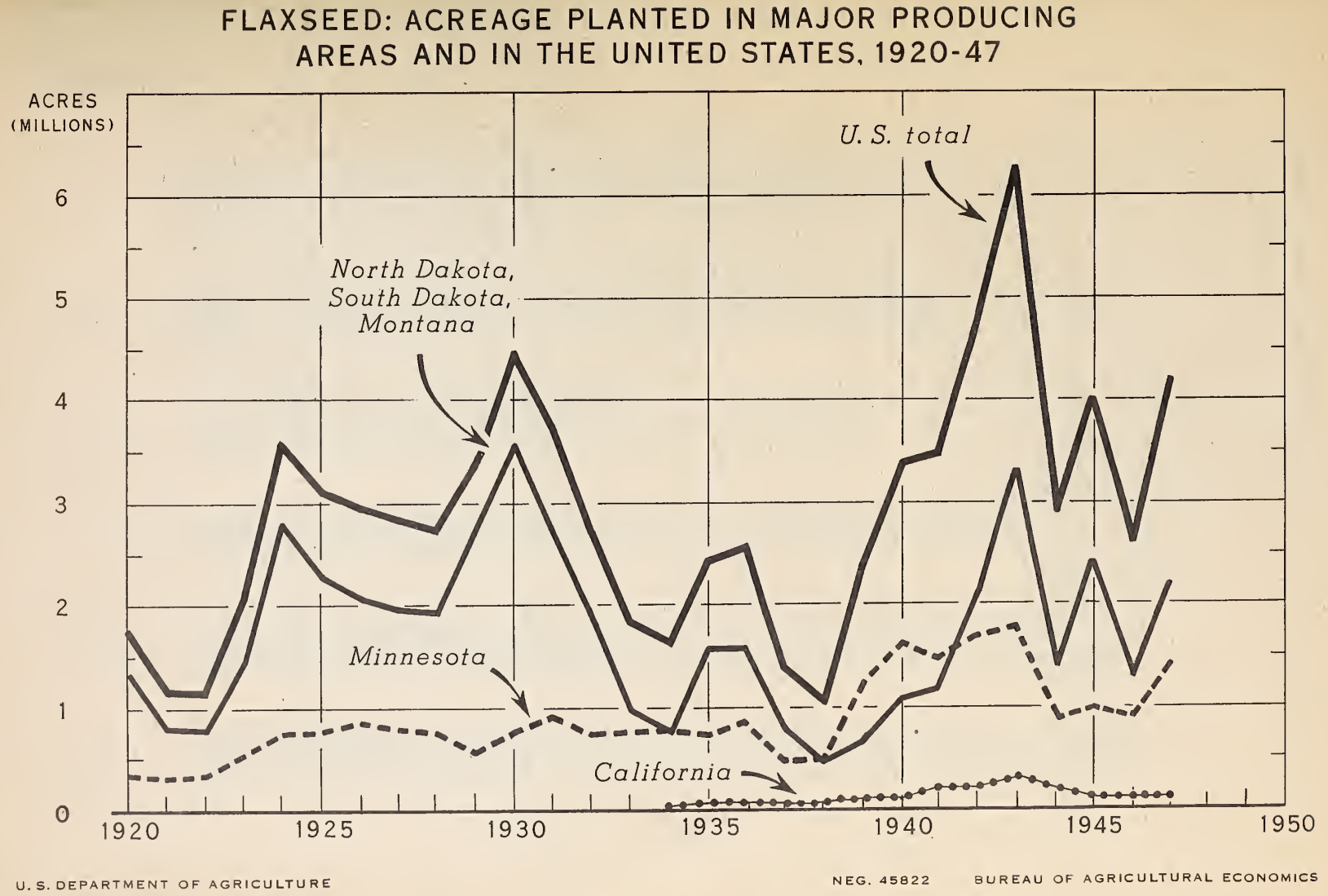

Figure 19.- The acreage of flaxseed is subject to extreme fluctuations. The 1943 acreage was more than three times the average of 1935-39, the acreage fell off sharply in 1944, but it has remained well above the prewar level.

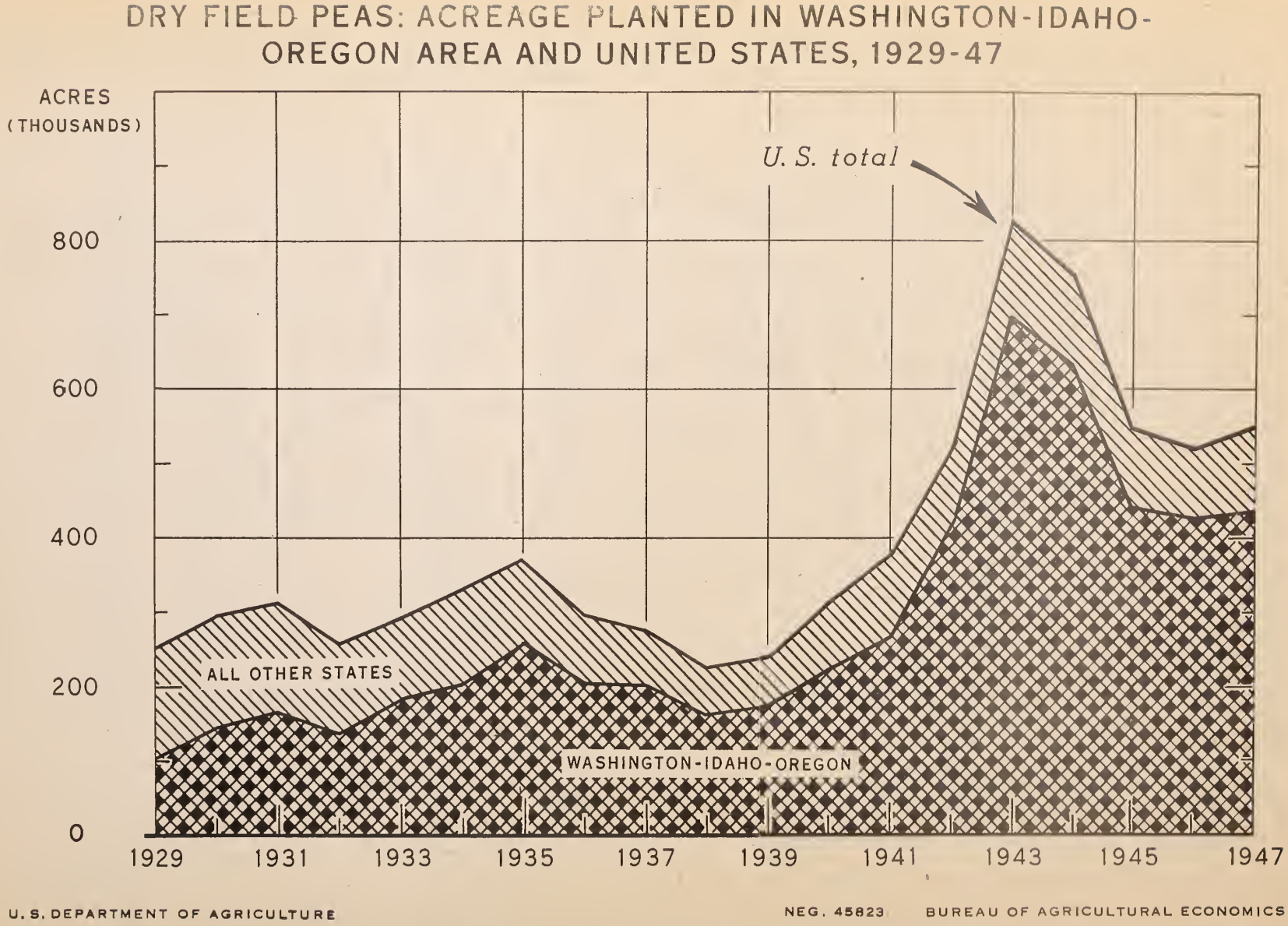

Figure 20.- The acreage of dry field peas rose sharply in the early years of World War II and reached a peak in 1943. The Pacific Northwest States produce the bulk of the United States output.

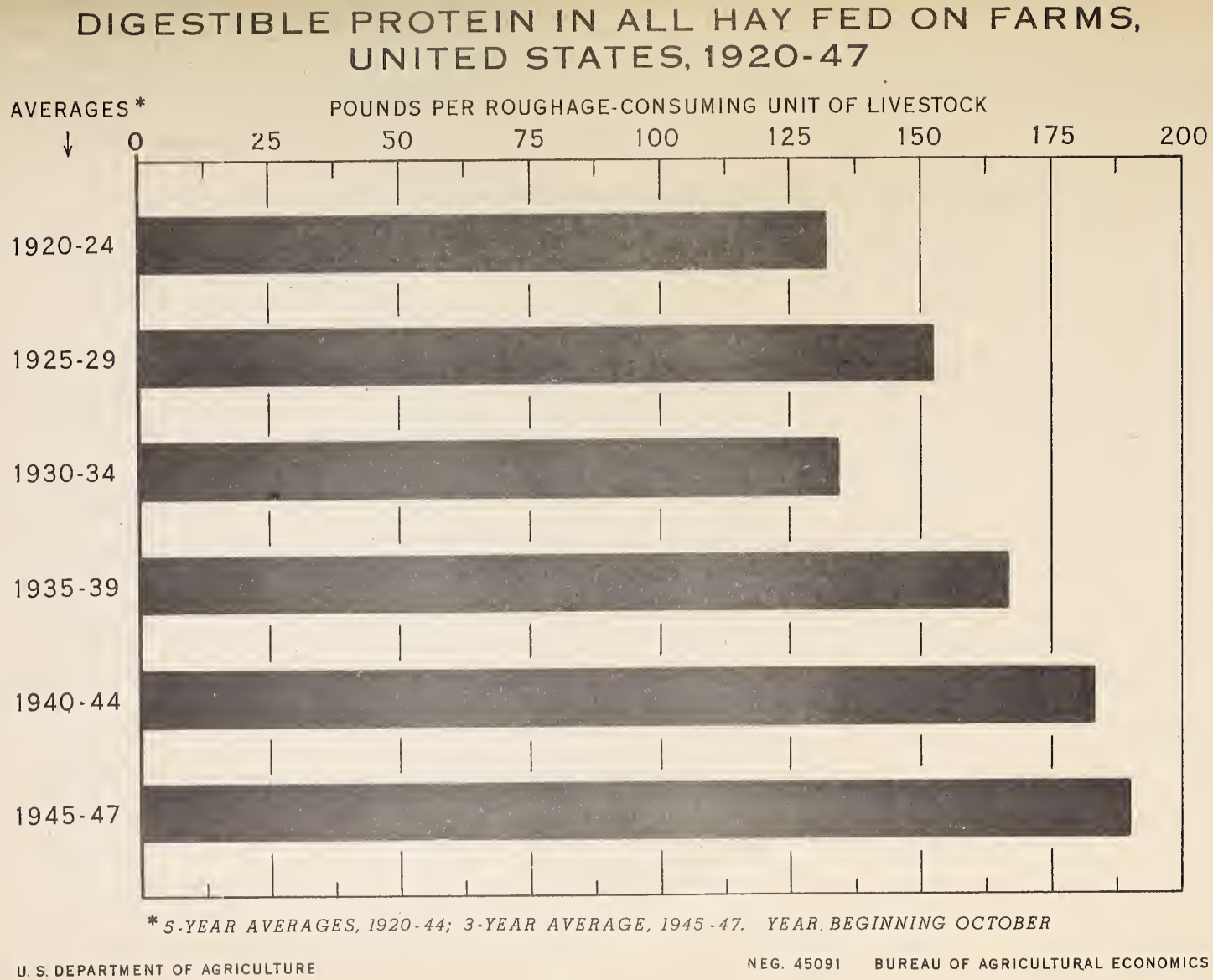

Figure 21.- Significant changes have taken place in both quantity and quality of the country's hay supply. An average of about 44 percent more digestible protein was available per roughage-consuming unit of livestock in the years 1945-47 than in the years 1920-24. The pronounced shift from grass to legume hays has been the largest contributing factor.

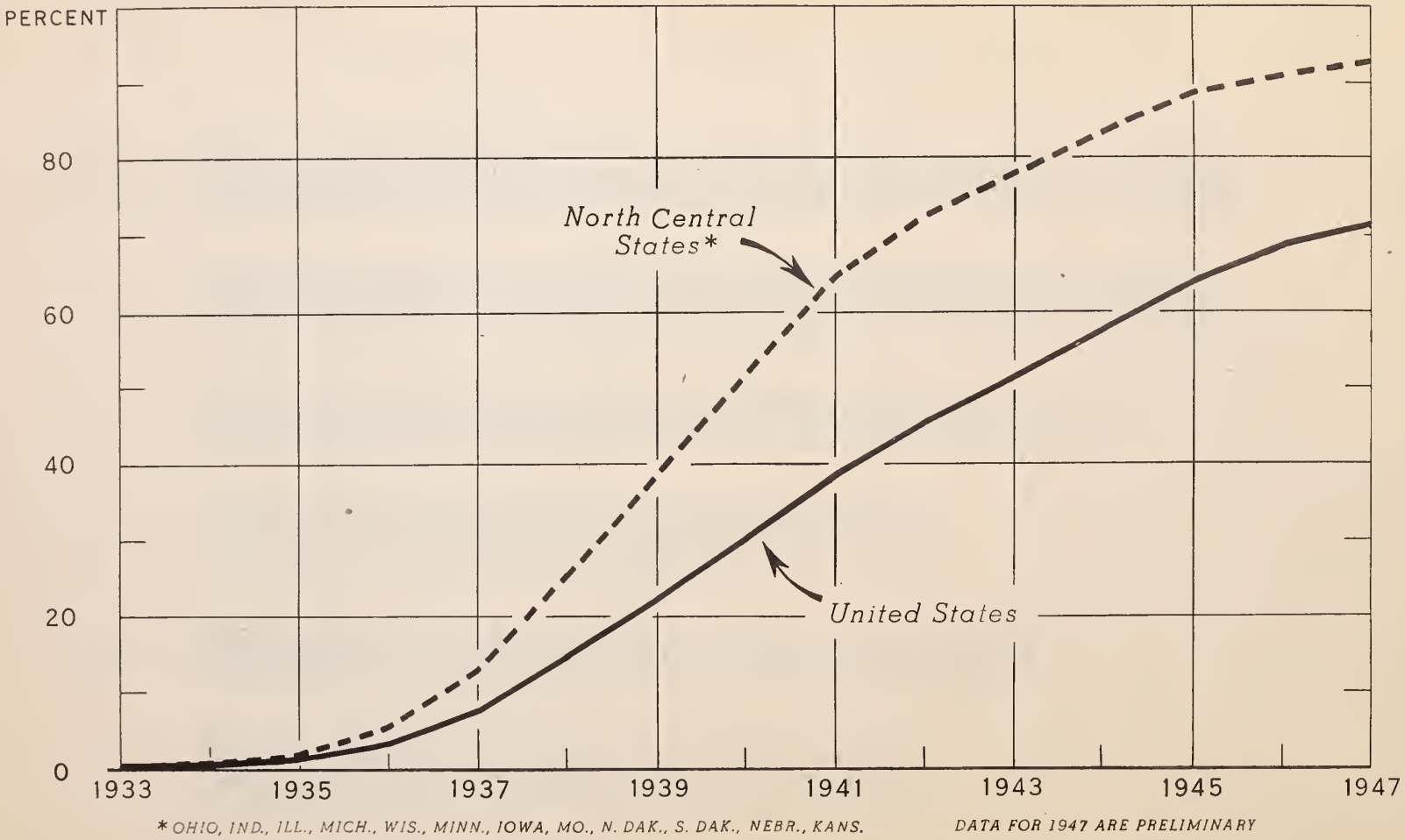

Figure 22.- From the merest beginnings in 1933, hybrid seed had replaced open-pollinated varieties on about three-fourths of the total acreage planted in 1947. The increase has been most rapid in the North Central States, where it was used for planting 93 percent of the acreage in 1947.

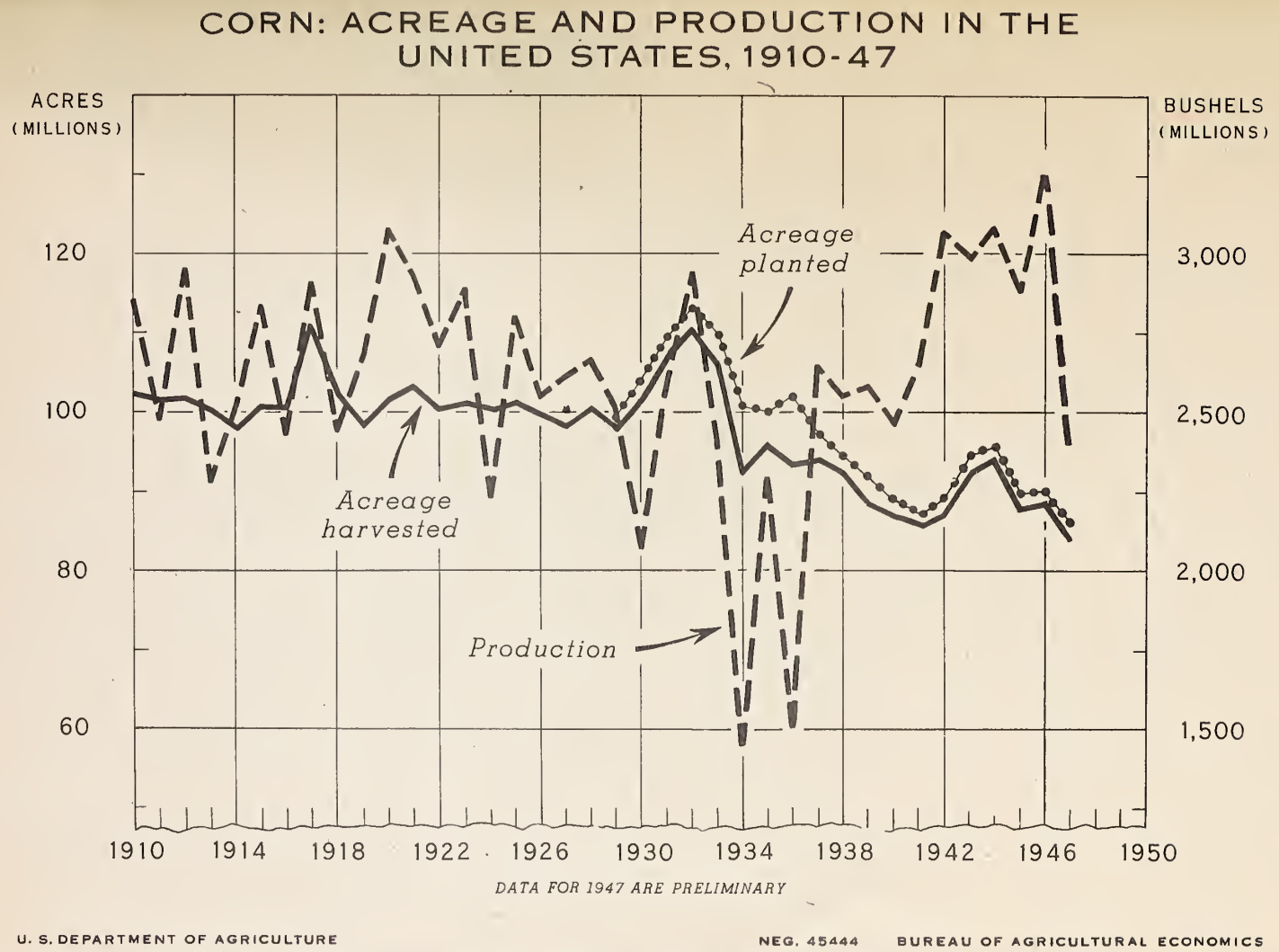

Figure 23.- The acreage of corn harvested in the United States remained approximately stable from 1910 to 1930--at about 100 million acres--except in 1917, when a record acreage of corn was harvested under combined circumstances of World War I and an extraordinary winter-killing of wheat. During the depression--1931, 1932, and 1933--farmers in many areas increased their acreage in an effort to offset low prices. Drought and acreage allotments reduced the acreage previous to World War II, but the downward trend was reversed in the war years.

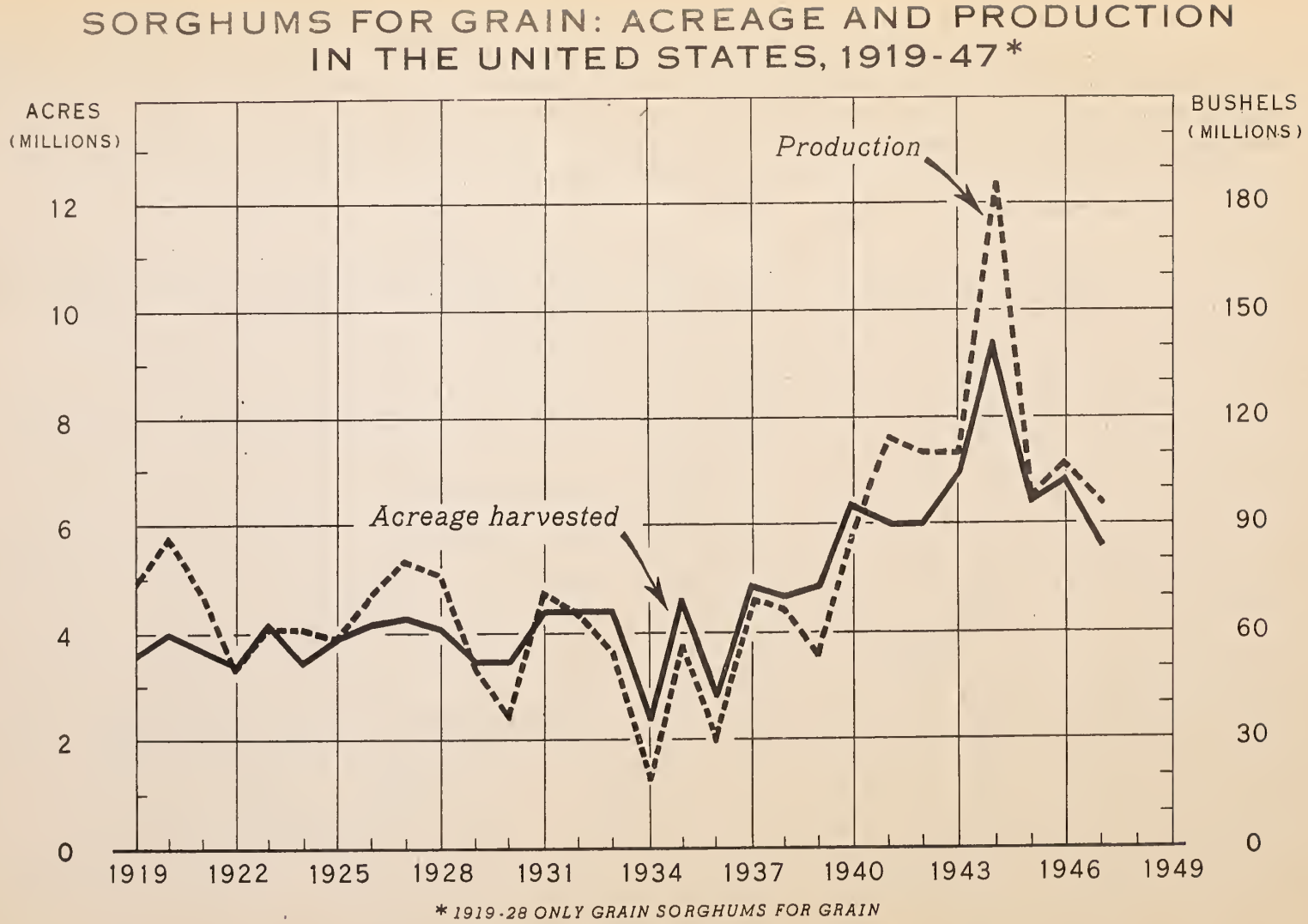

Figure 24.- Between 1919 and 1939 the acreage of sorghums harvested for grain averaged about 4 million acres. Production fluctuated greatly during this period because the crop is grown under very hazardous weather conditions. Both acreage and production since 1939 have been far above the prewar level.

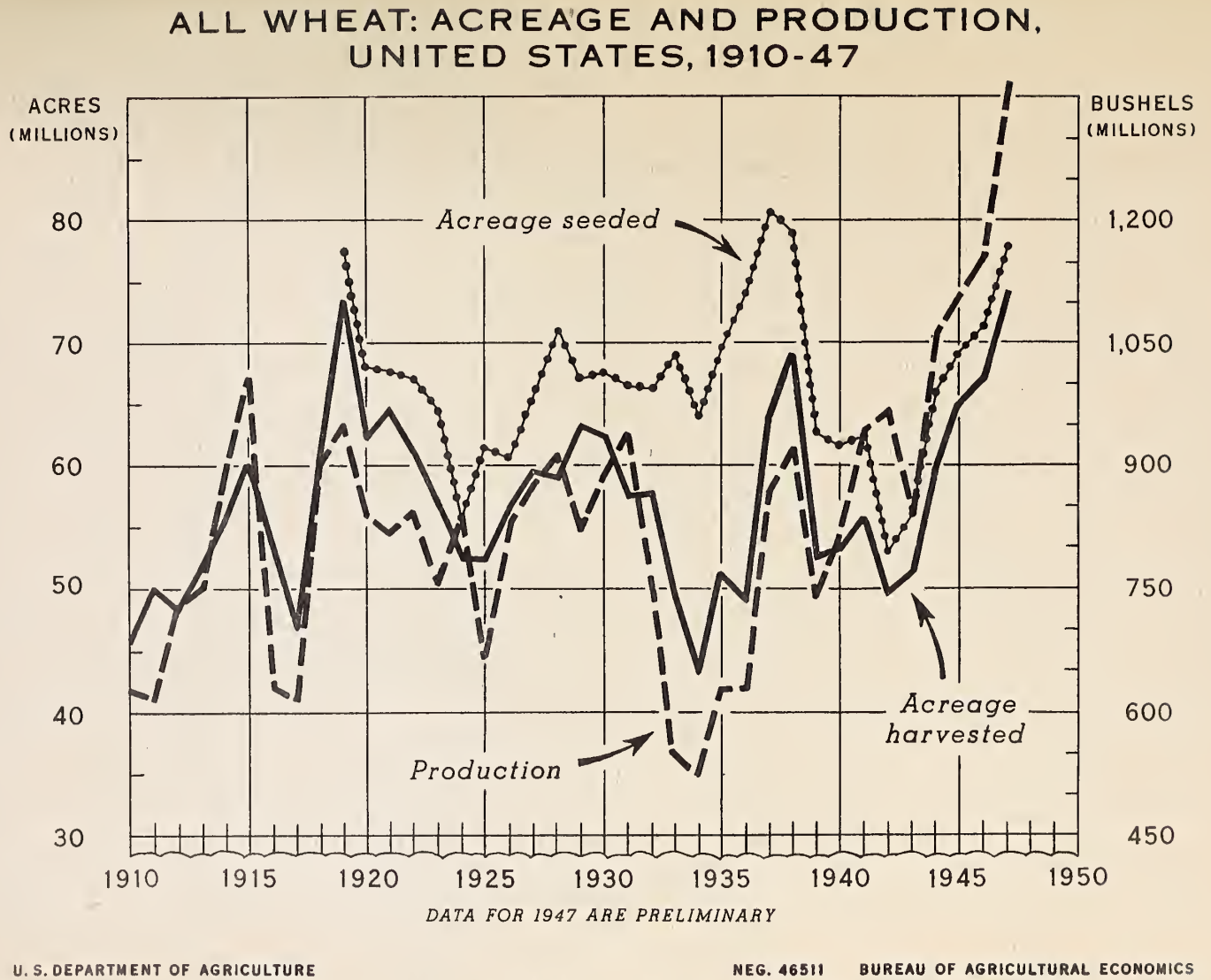

Figure 25.- Most of the wheat is grown in areas of relatively low rainfall. Both the acreage harvested and production therefore are greatly affected by weather conditions. Acreage and production remained at low levels during the war years, but new records in wheat production were established in the postwar years 1946 and 1947.

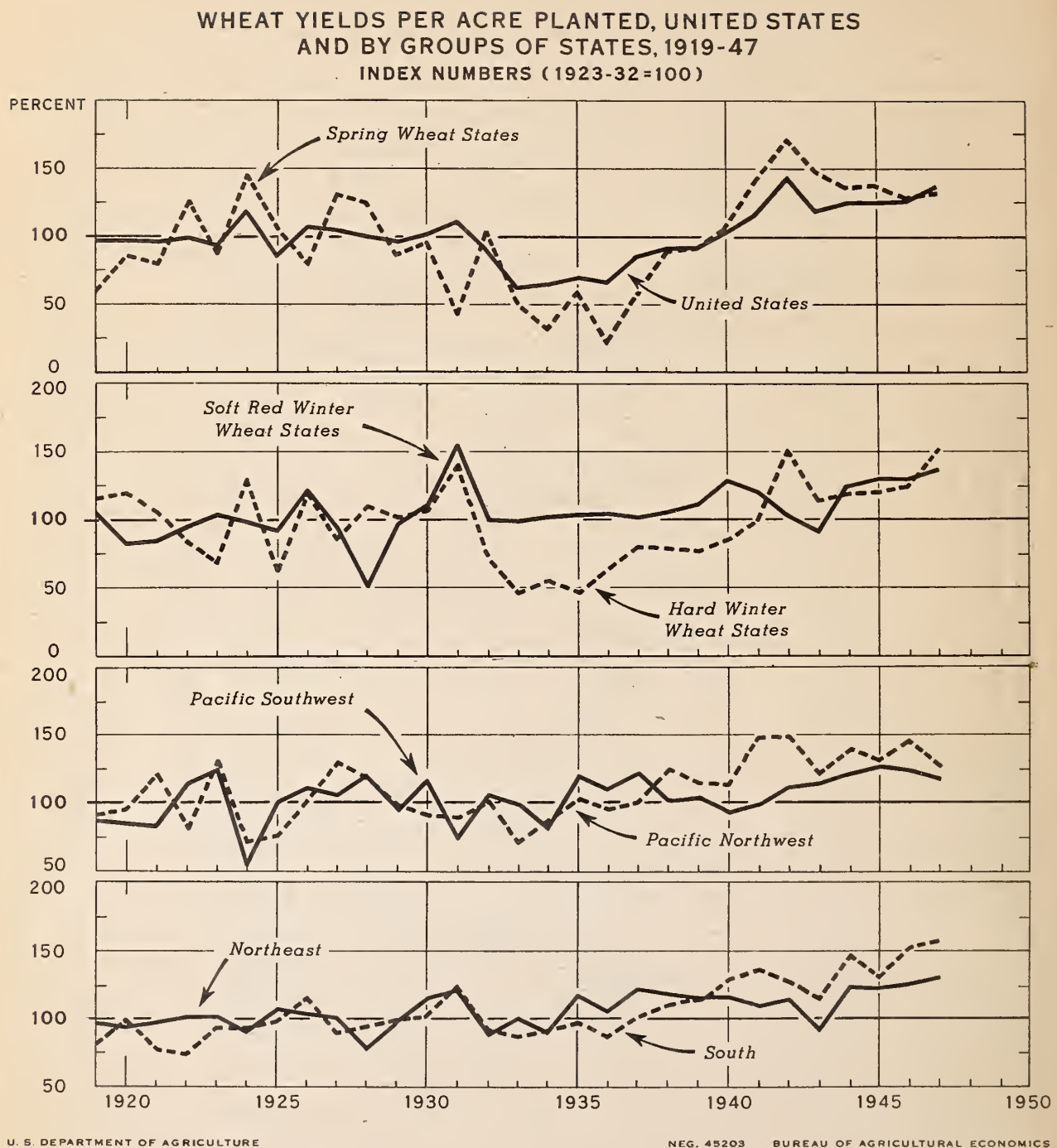

Figure 26.- Yields of wheat have been above the 1923-32 average in most years since 1940, in all regions. Yields in the Pacific Northwest and the Southern States since 1938 have been materially higher than during the 10-year 1923-32 period before the droughts.

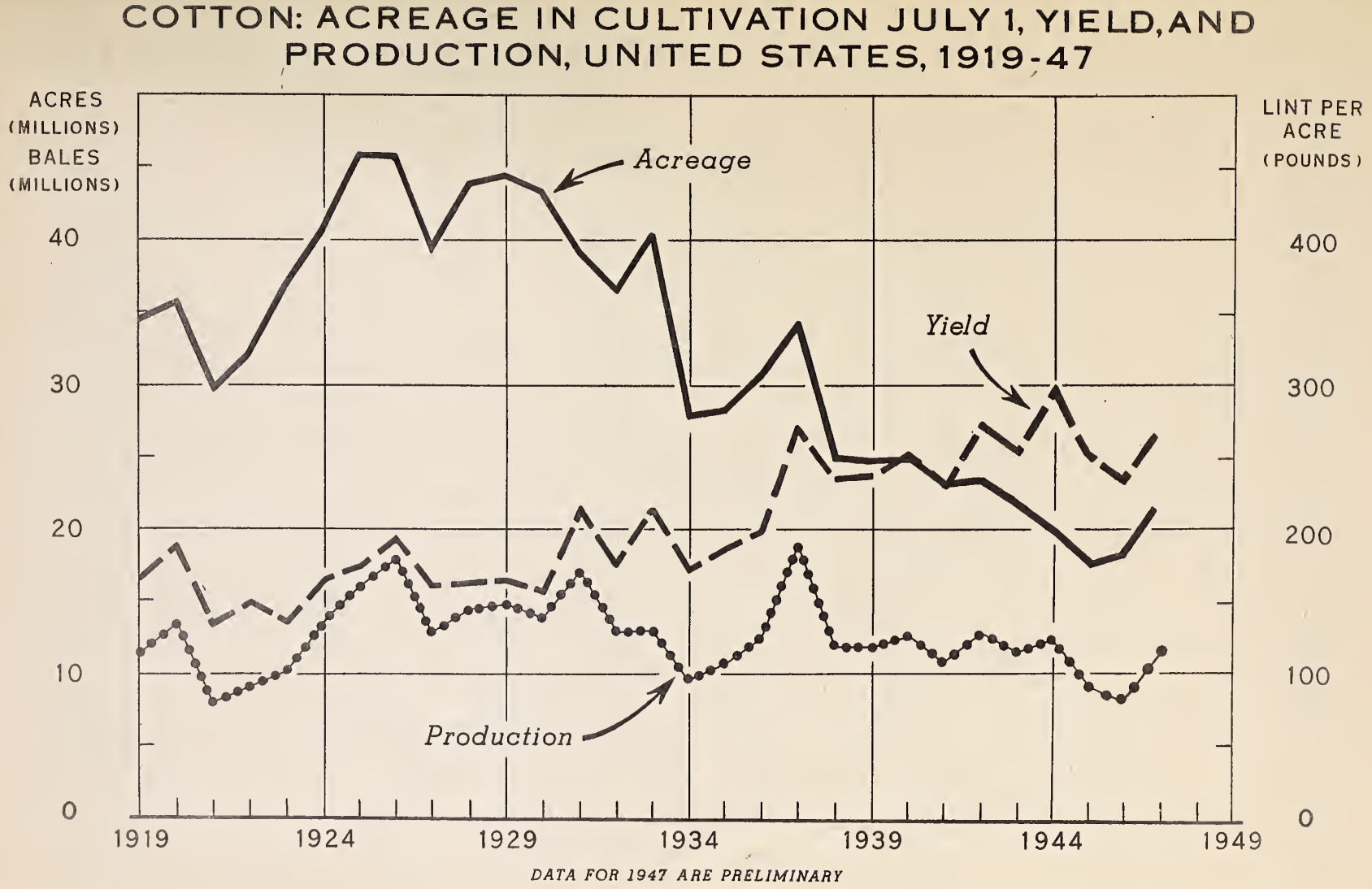

Figure 27.- Cotton acreage was increasing from 1921 to 1926, when nearly 46 million acres were in cultivation. Since 1926 the general trend has been downward. Production shows a smaller downward tendency than acreage because the trend of yields has been upward.

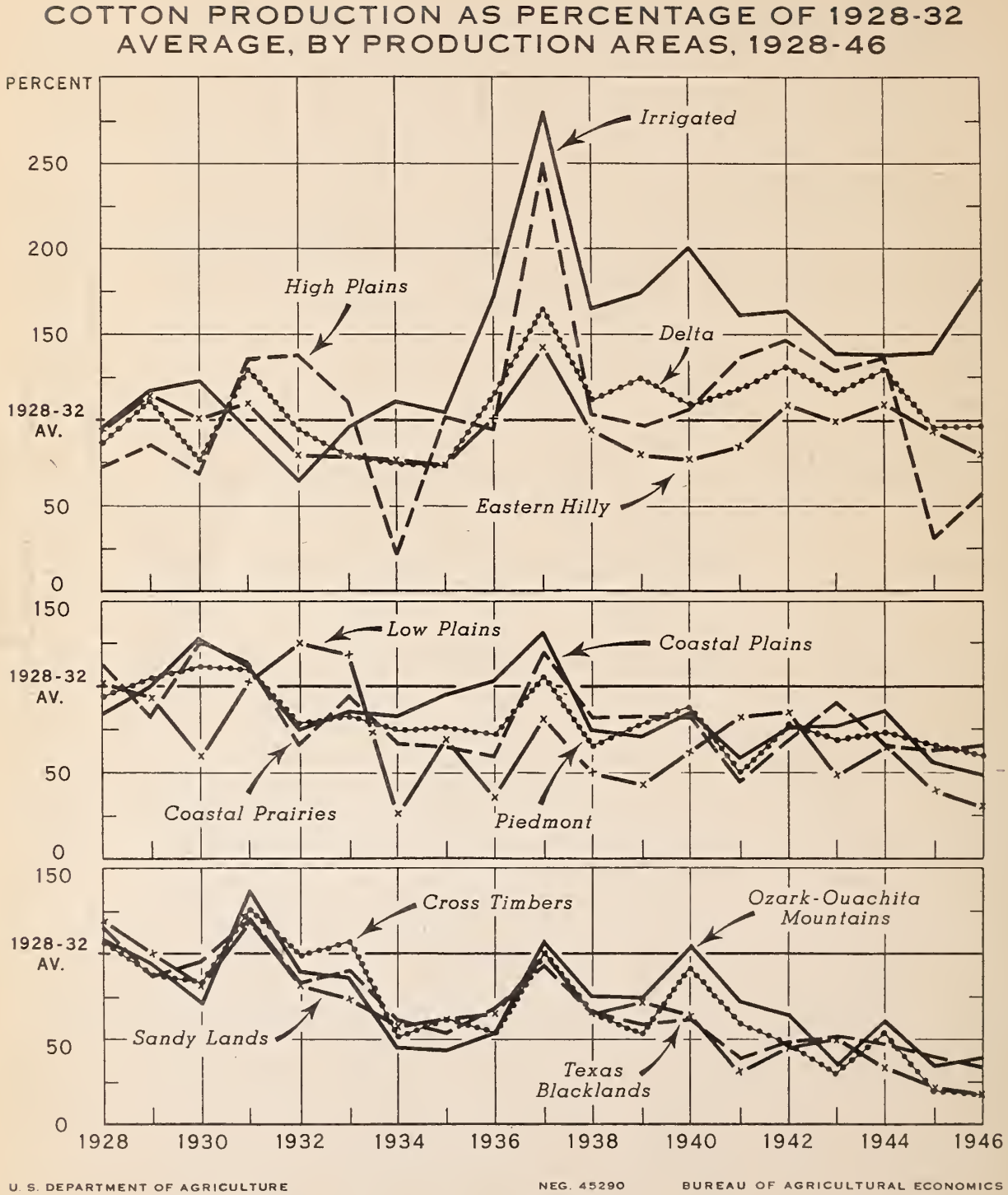

Figure 28.- The wartime cotton acreage was below the prewar level in all except the irrigated areas. This resulted in decreased production except in the areas where higher yields have more than offset the smaller acreage.

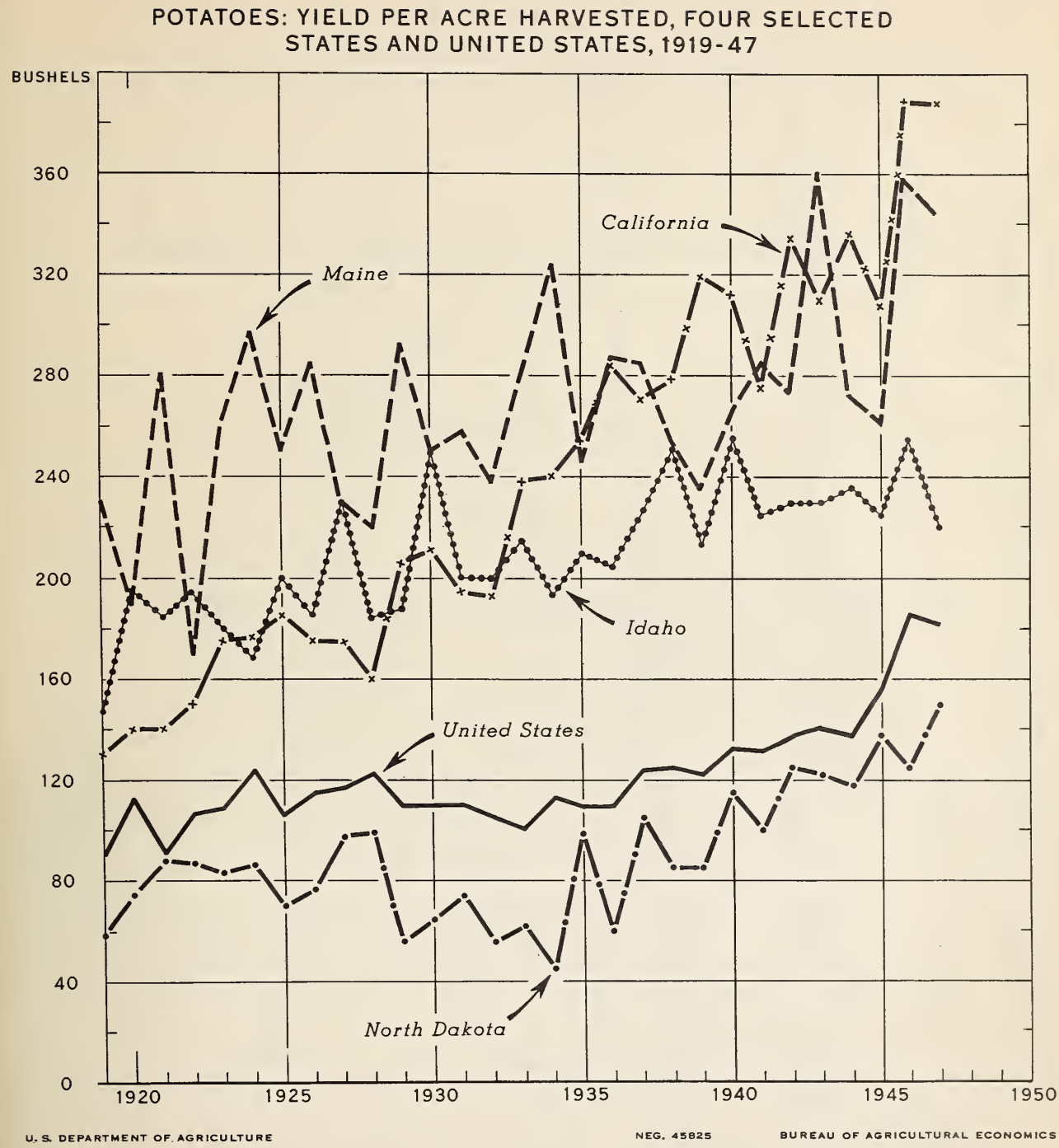

Figure 29.- Maine, Idaho, and California produce about one-third of the potatoes grown in the United States. They are the only States that consistently show yields above 200 bushels per acre. Production there is concentrated on land best suited to potatoes and in relatively large-scale enterprises. North Dakota production has shown a marked shift from farm production for home supply to commercial production in the Red River Valley. The marked upward trend in United States average yields reflects the extension of acreage by commercial growers who apply effective production practices.

ACREAGE AND PRODUCTION OF CITRUS FRUITS AND OF 12 OTHER MAJOR FRUITS, UNITED STATES, 1929-47

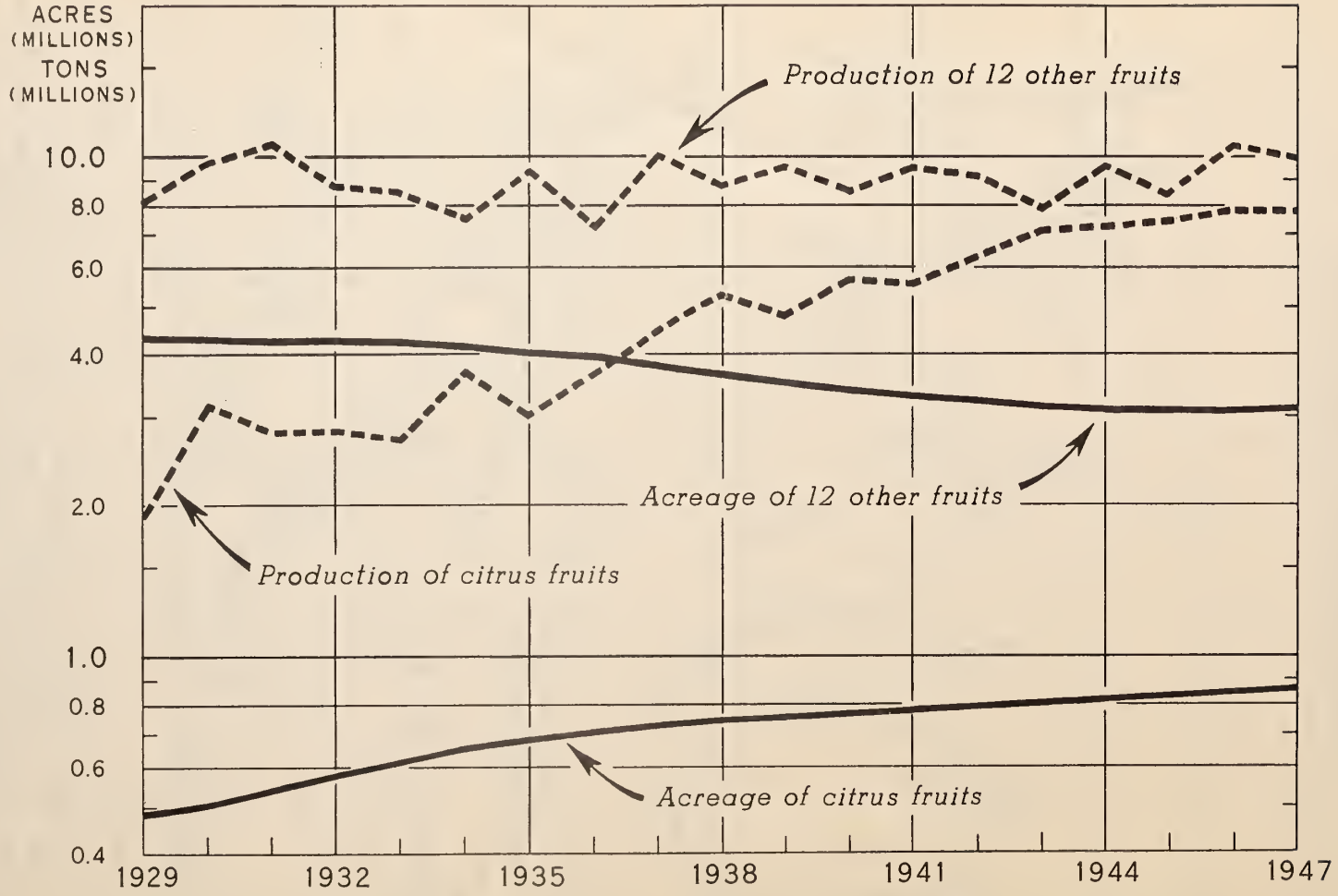

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Figure 30.- Acreage of citrus fruit has steadily increased since 1930, while the acreage of deciduous fruits has declined. The increase in production of all fruits is almost entirely due to the rapid increase in production of citrus fruits, which account for almost one-half of total production on a tonnage basis. This is a ratio chart showing equal percentage changes.

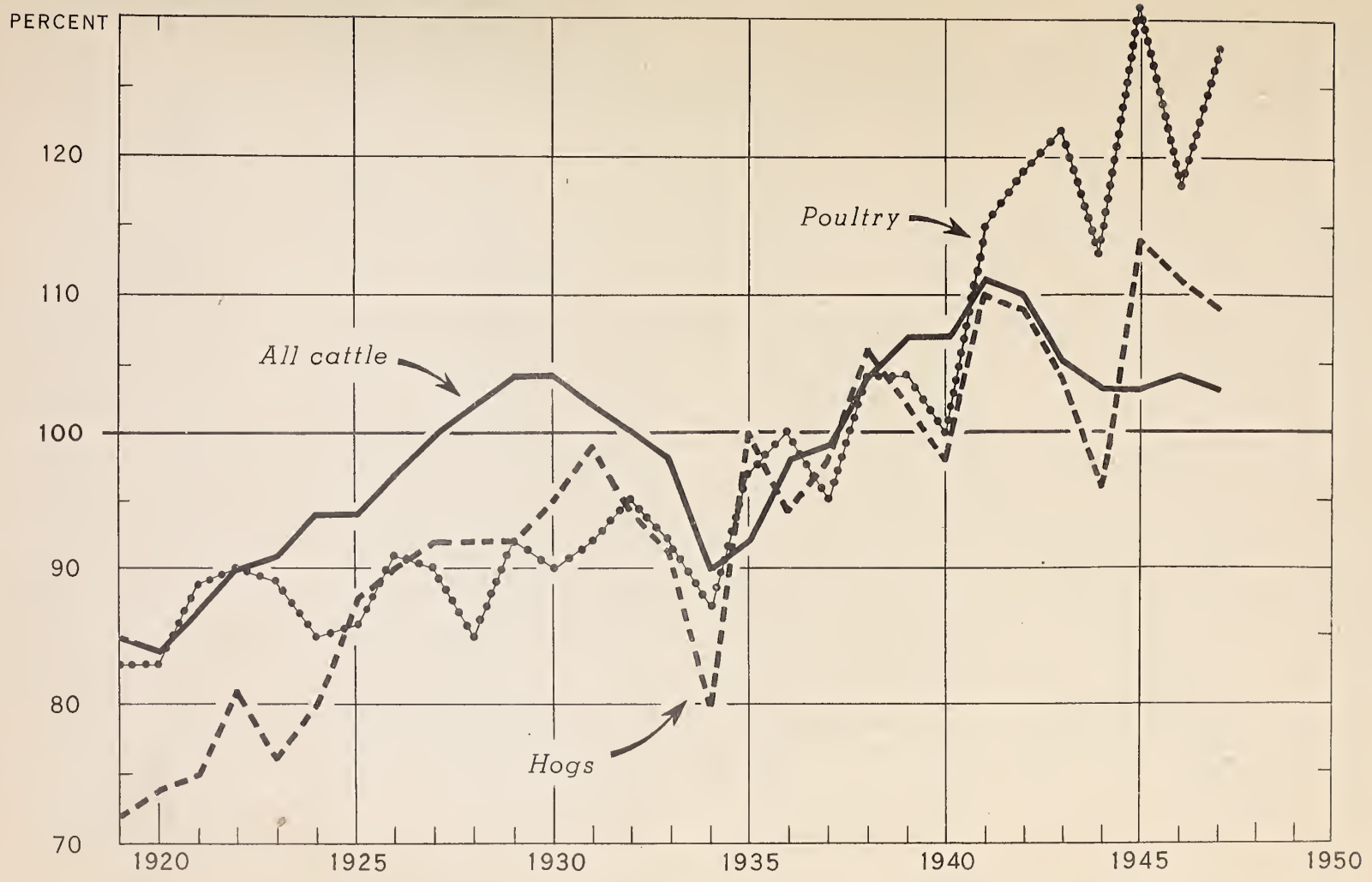

Figure 31.- Poultry and hog production per unit of breeding livestock have moved sharply upward since 1919. There has also been an upward trend in cattle production per unit.

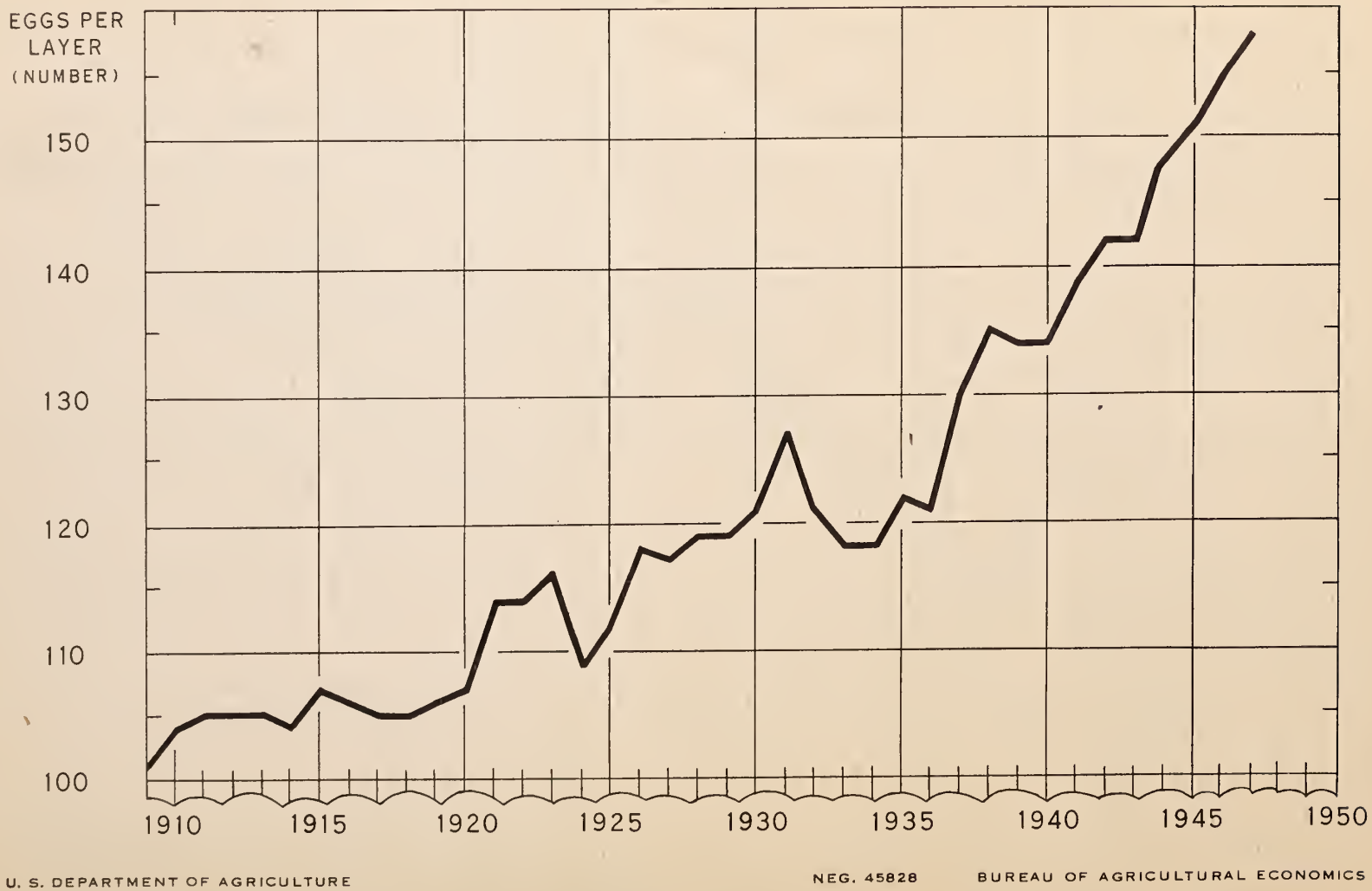

Figure 32.- Egg production per layer made an upward climb of 50 percent from 1909 to 1945. There is still no indication of leveling off.

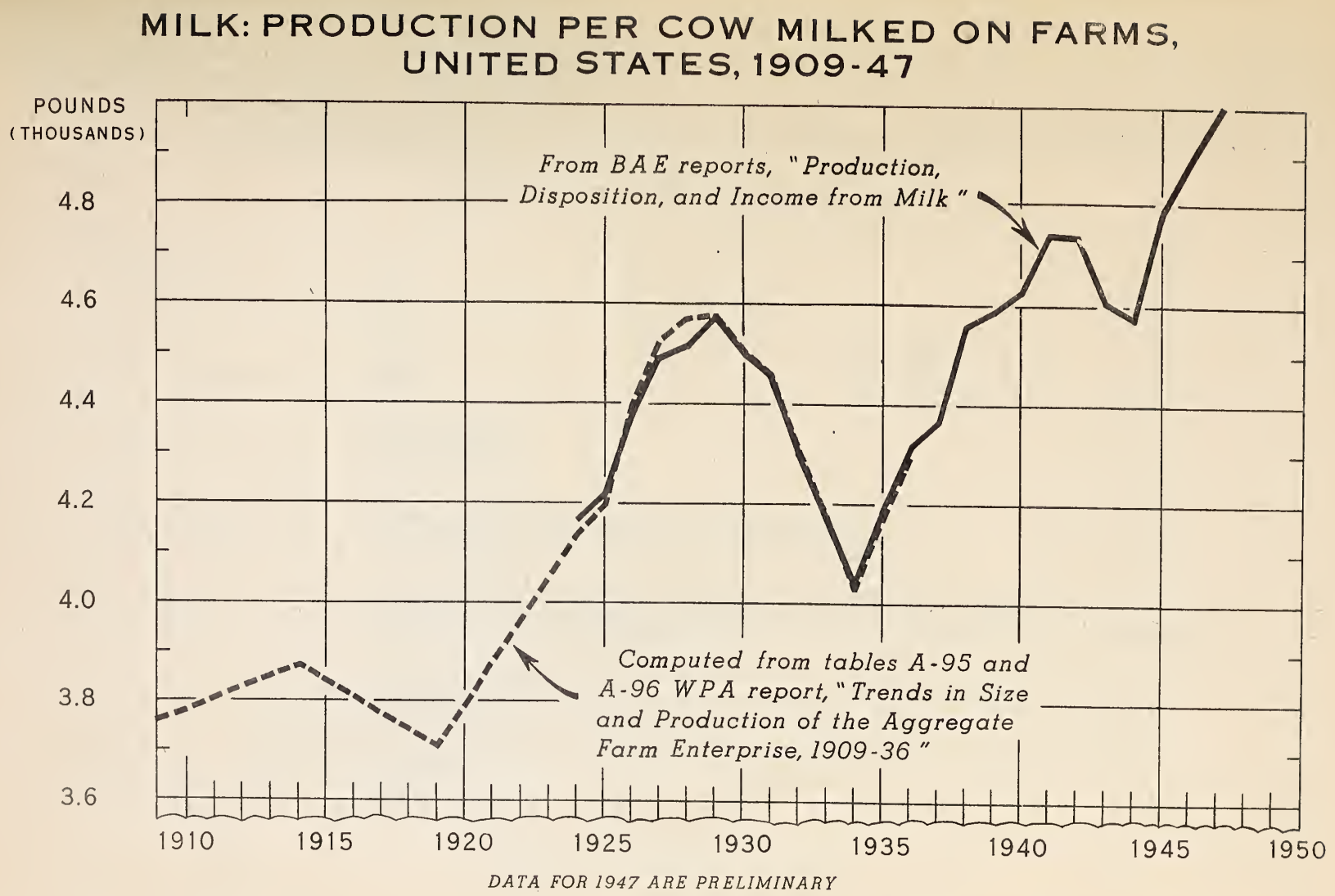

Figure 33.- A definite upward trend in milk production per cow for the period since 1909 was interrupted briefly during World War I, and then for a longer time in the drought and depression of the 1930's. An all-time peak was reached in 1947.

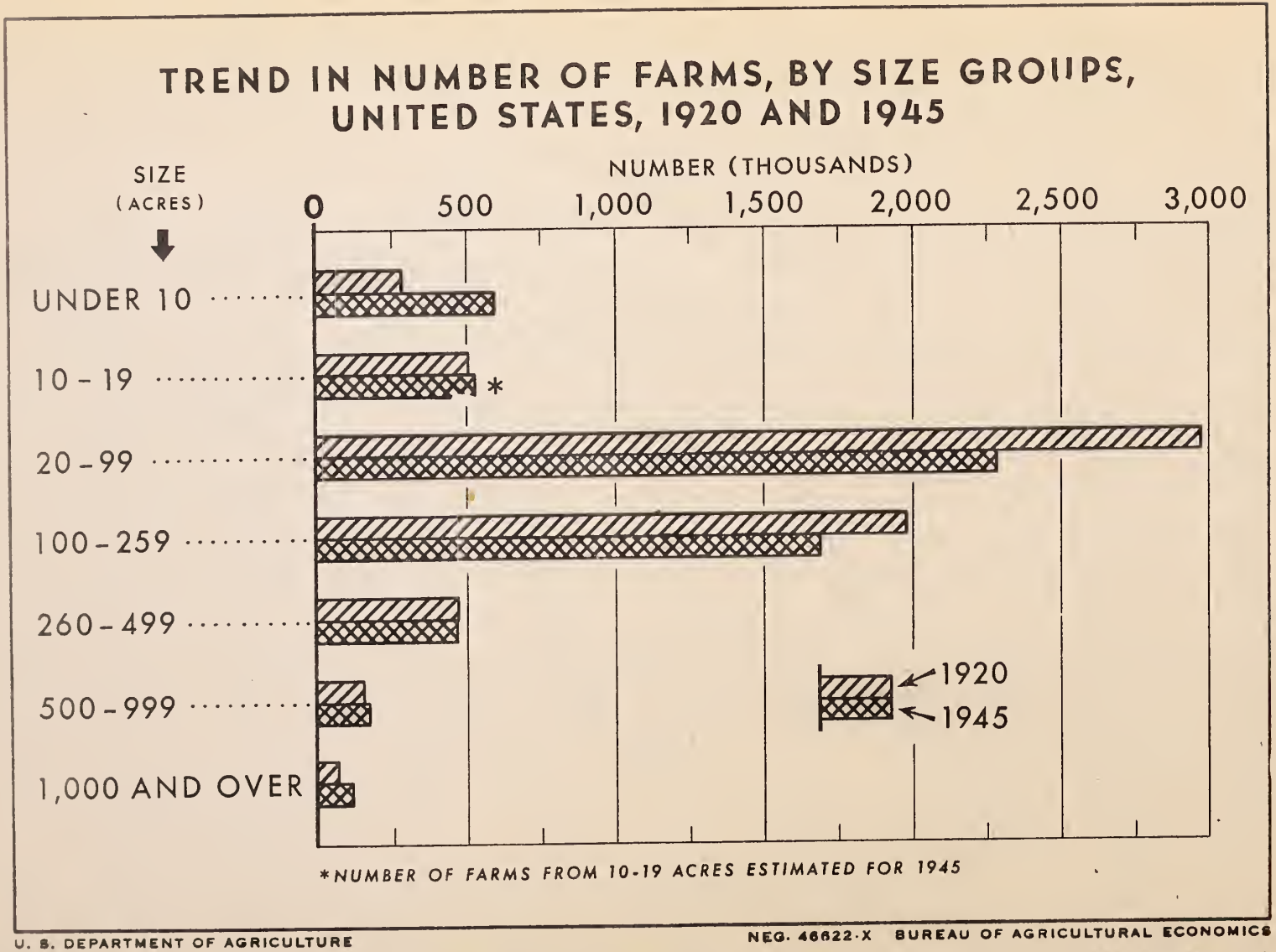

Figure 34.- In the quarter-century from 1920 to 1945 the number of farms under 10 acres enumerated by the census more than doubled. The number of farms in the size groups from 20 to 259 acres decreased substantially; and there was a large percentage increase in the farms of over 1,000 acres, which was largely accounted for by wheat farms and livestock ranches in the Western States.

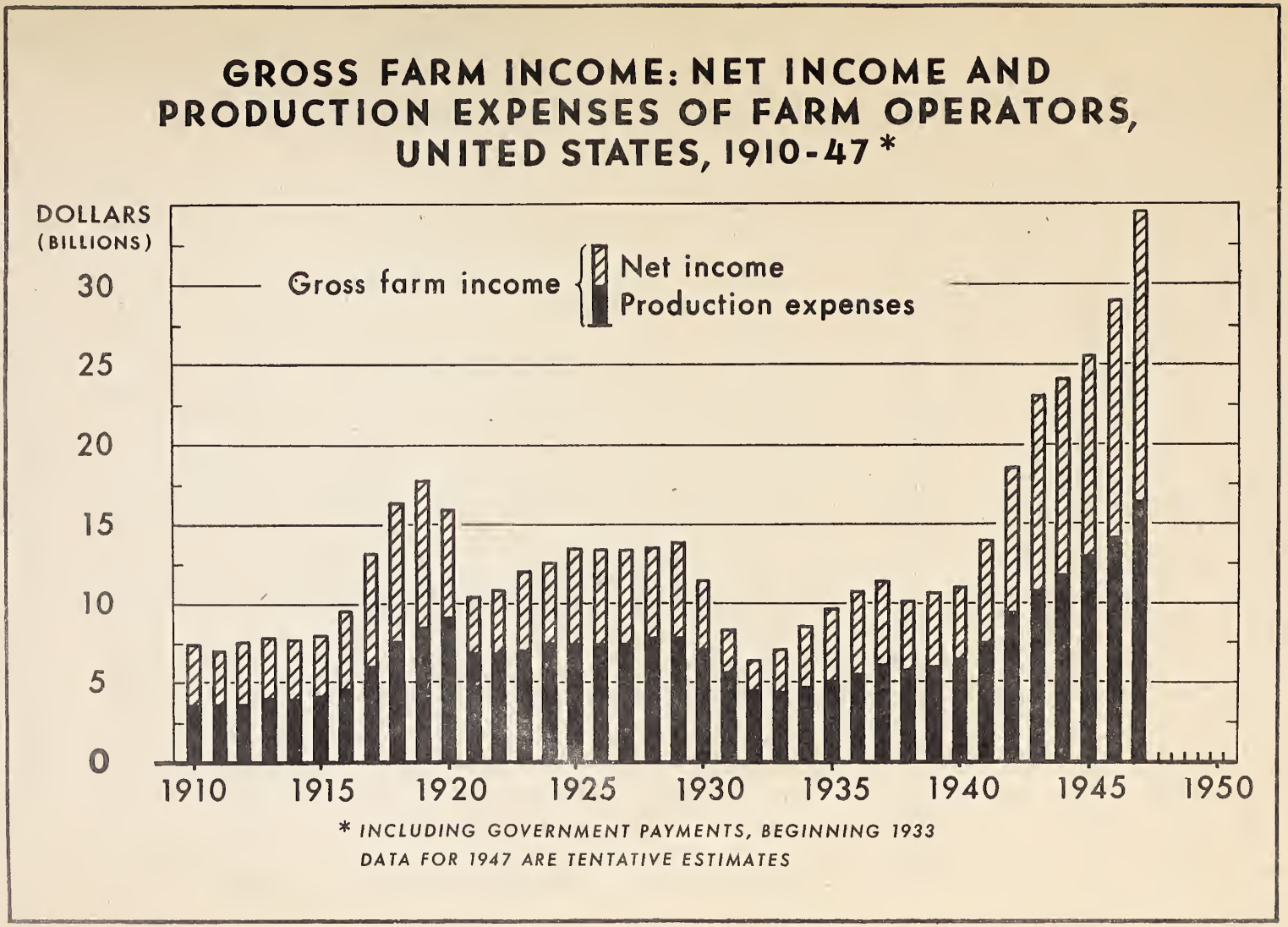

Figure 35.- Production expenses of farm operators have increased since 1940 but gross farm income has increased more rapidly than expenses, resulting in a higher net income for farm operators.

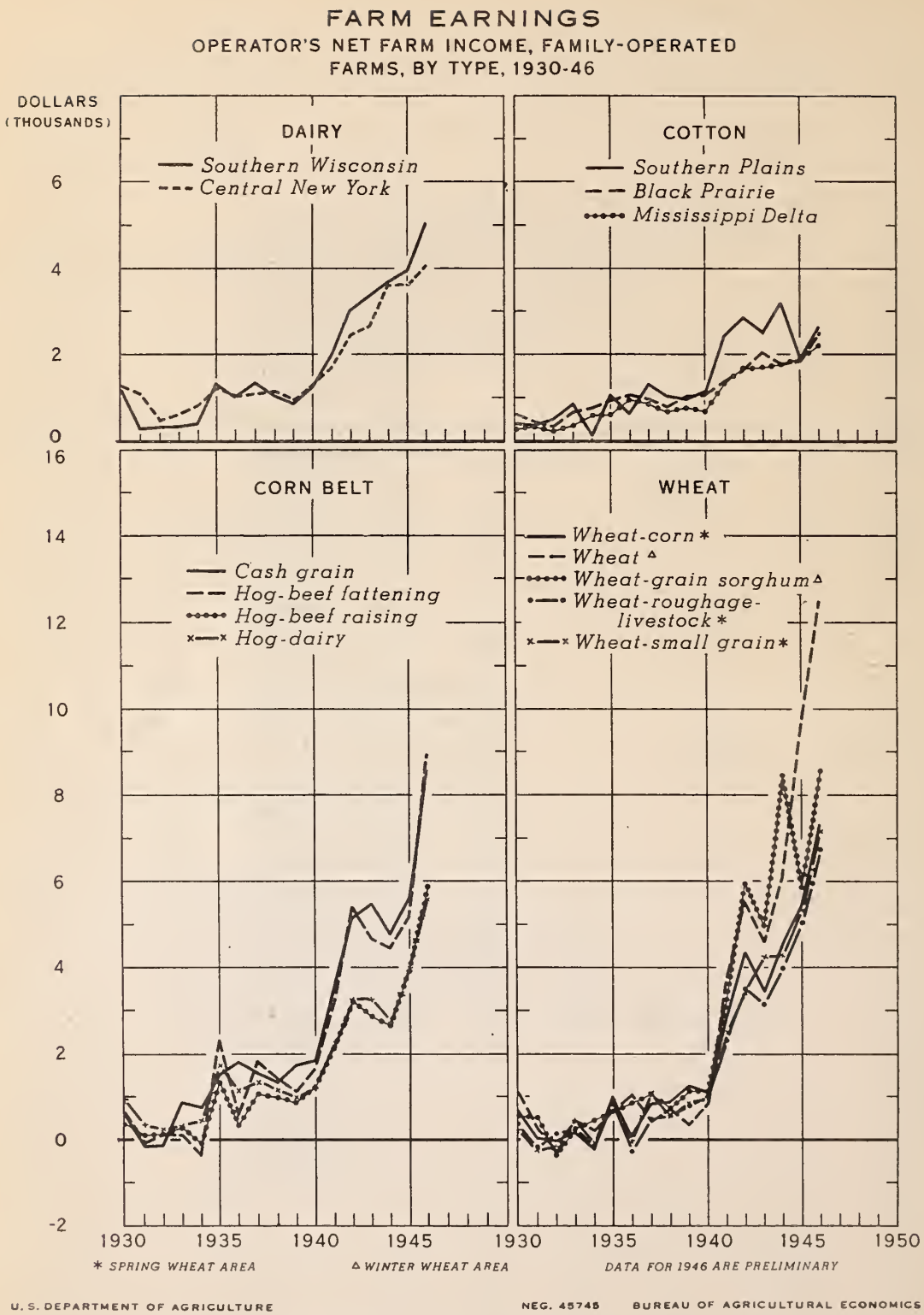

Figure 36.- Annual earnings of farm families operating all types of farms seem to follow the same general pattern. The extremely low net incomes of the drought and depression years 1931-36 were followed by some recovery in the late 1930's. The sharp rise in the war years resulted from higher prices combined with increased production per farm.

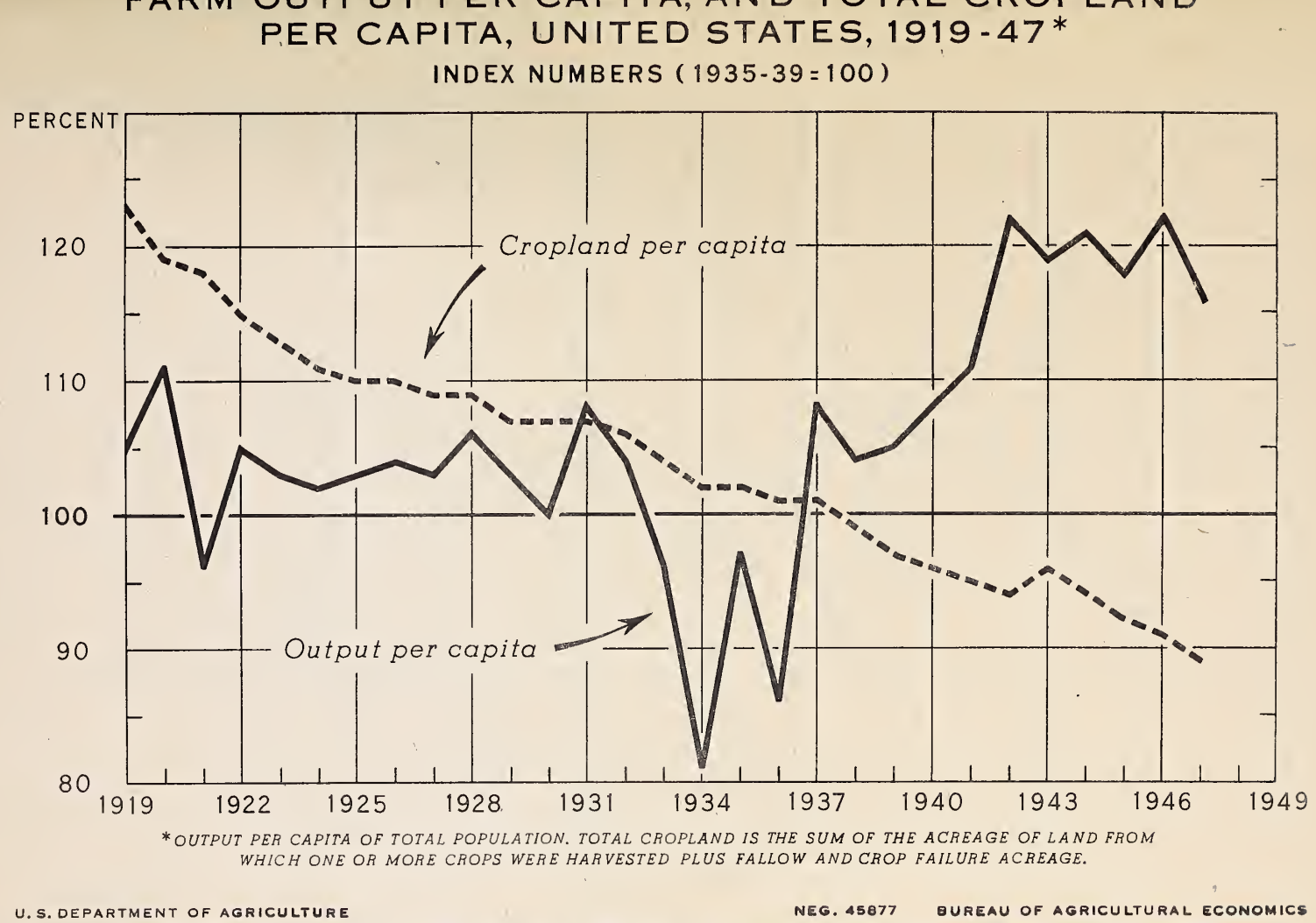

Figure 37.- Cropland acreage per capita has decreased almost steadily for more than a quarter-century, while the per capita output of farm products was maintained in most of the interwar years and increased sharply during the war. Release of cropland from production of horse and mule feed largely made possible the maintenance of output per capita in the interwar years. Increased crop production per acre was mostly responsible for the wartime expansion in output per capita.

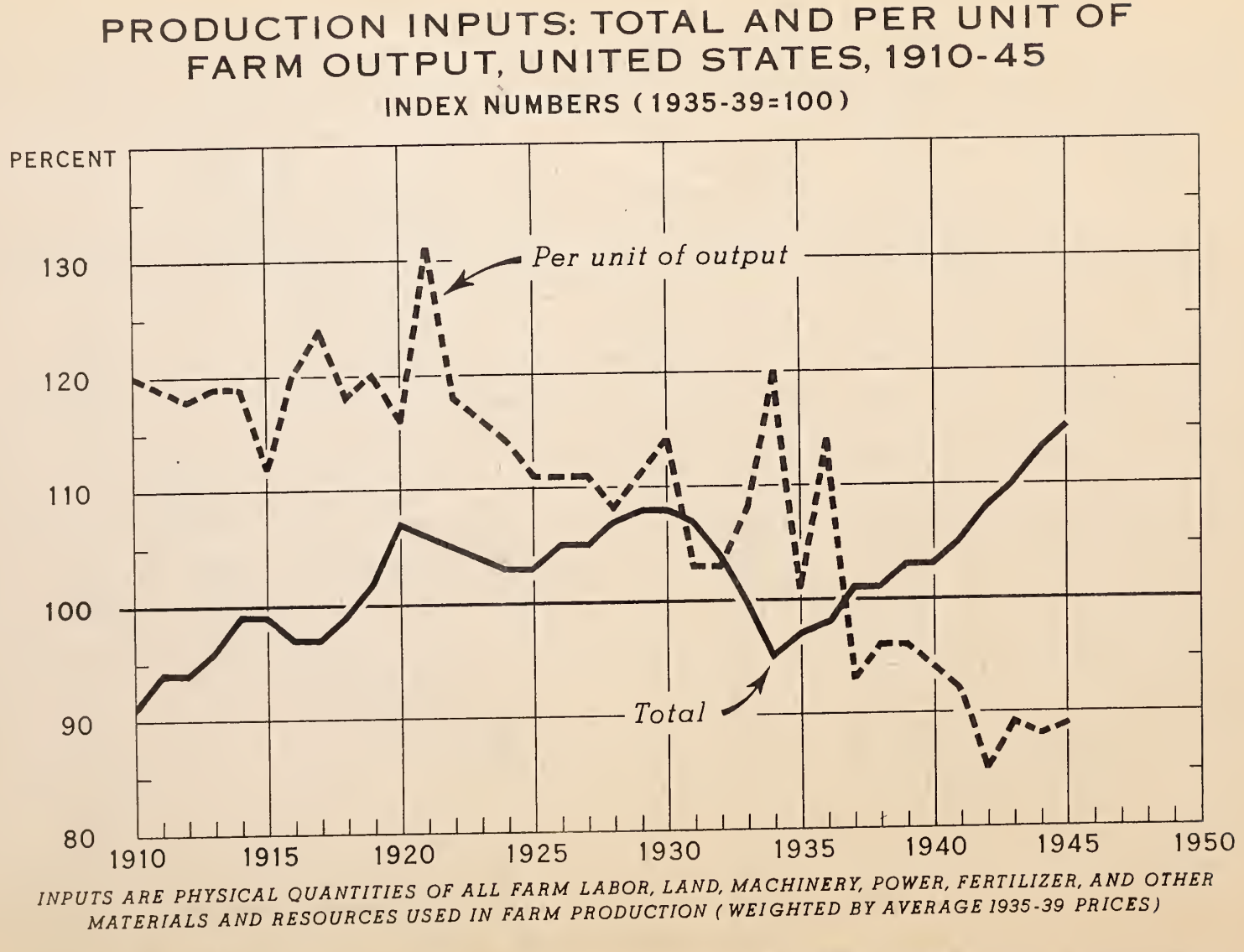

Figure 38.- Total physical inputs (farm labor, power and other resources) per unit of farm output decreased about 25 percent over the last quarter-century.

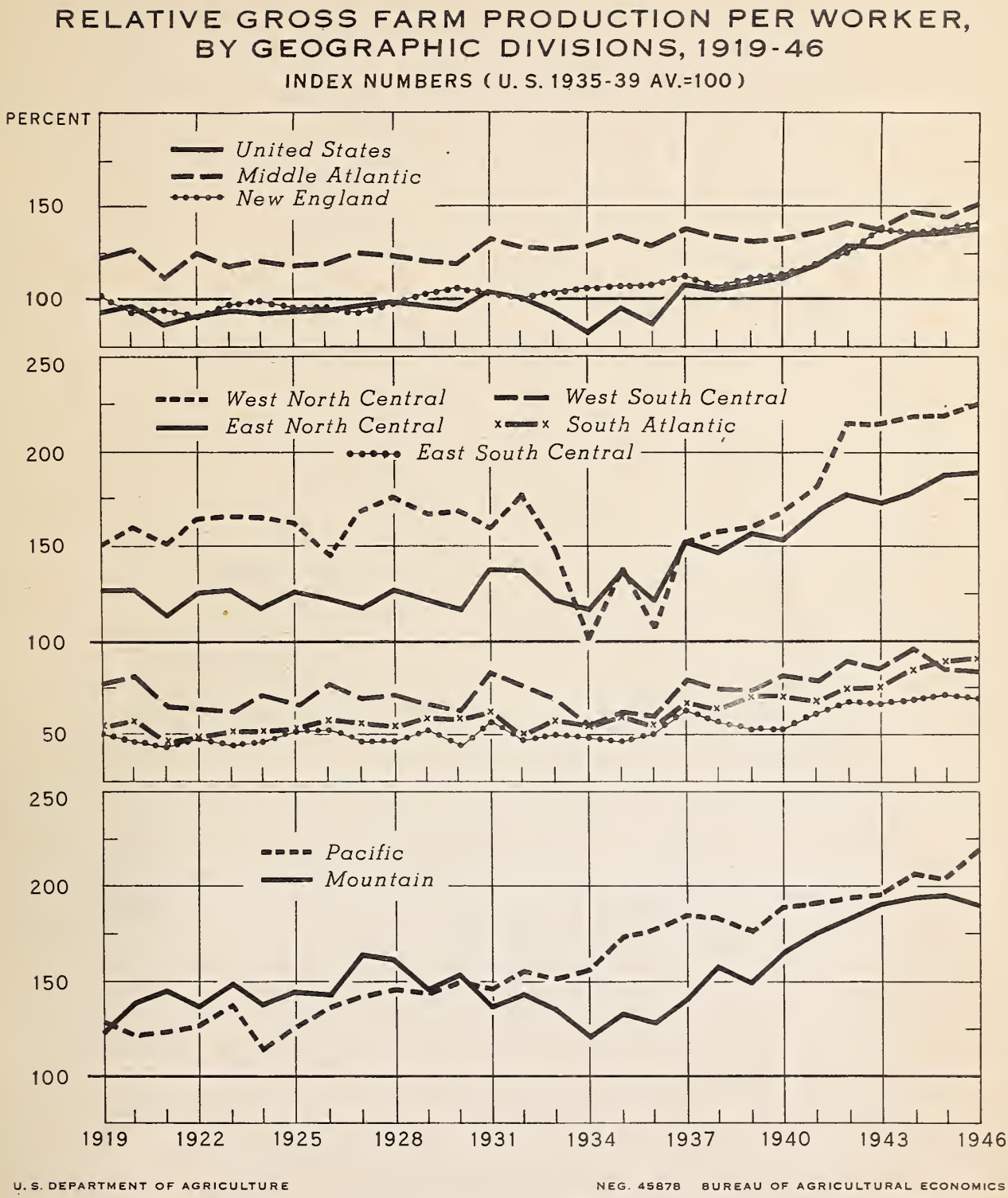

Figure 39.- Farm production per worker has been lowest in the Southern divisions during the entire period 1919-46. The most consistent upward trend in production per worker has taken place in the Pacific division, although relatively greater wartime increases occurred in the North Central and Mountain divisions.

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